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FORM PTO-1390 REV. 5-93 US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE **TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**		ATTORNEYS DOCKET NUMBER **P01,0029** U.S.APPLICATION NO. (if known, see 37 CFR 1.5) 09/830225
INTERNATIONAL APPLICATION NO. **PCT/DE99/03191**	INTERNATIONAL FILING DATE 4 October 1999	PRIORITY DATE CLAIMED 23 October 1998

TITLE OF INVENTION
"METHOD AND DEVICE FOR PROCESSINGIGITIZED IMAGE"

APPLICANT(S) FOR DO/EO/US
Thomas RIEGEL

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C.371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; **(PTO 1449, Prior Art, Search Report)**.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included. **(SEE ATTACHED ENVELOPE)**
13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☒ A substitute specification & marked up version of application.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
    a. ☒ Submittal of Drawings
    b. ☒ **EXPRESS MAIL #EL 843728380US, dated April 23, 2001.**

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U.S. APPLICATION NO (if known, see 37 C.F.R 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/830225	PCT/DE99/03191	P01,0029

				CALCULATIONS	PTO USE ONLY
17. ☒ The following fees are submitted: **BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):** Search Report has been prepared by the EPO or JPO .... $860.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) ..... $700.00 No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2) .... $770.00 Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO .... $1040.00 International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) .... $ 96.00					
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	30 - 20 =	10	X $ 18.00	$ 180.00	
Independent Claims	2 - 3 =		X $ 80.00	$	
Multiple Dependent Claims			$270.00 +	$	
TOTAL OF ABOVE CALCULATIONS =				$ 1040.00	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)				$	
SUBTOTAL =				$ 1040.00	
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 1040.00	
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +					
TOTAL FEES ENCLOSED =				$ 1040.00	
				Amount to be refunded	$
				charged	$

a. ☒ A check in the amount of $ 1040.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ________ in the amount of $ ______ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **501519**. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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IN THE UNITED STATES ELECTED OFFICE
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

"**PRELIMINARY AMENDMENT**"

APPLICANT: Thomas RIEGEL

SERIAL NO.: EXAMINER:

FILING DATE: ART UNIT:

INTERNATIONAL APPLICATION NO.: PCT/DE99/03191

INTERNATIONAL FILING DATE: 4 October 1999

INVENTION: METHOD AND DEVICE FOR PROCESSINGIGITIZED IMAGE

Hon. Assistant Commissioner for Patents
Box PCT
Washington D.C. 20231

SIR:

Amend the above-identified international application before entry into the national stage before the U.S. Patent & Trademark Office under 35 U.S.C. §371 as follows:

IN THE SPECIFICATION

The specification has been amended as follows:

SPECIFICATION

TITLE

METHOD AND ARRANGEMENT FOR PROCESSING A DIGITALIZED

IMAGE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is directed to an arrangement and to a method for processing a digitalized image as utilized and implemented in the framework of an encoding and decoding of a digitalized image.

Such a method and such an arrangement are utilized in the framework of an encoding and decoding of a digitalized image corresponding to one of the image encoding standards H.261 the publication by D. Le Gall, "The Video Compression Standard for Multimedia Applications", Communications of ACM, H.263 the publication by G. Wallace, "The JPEG Still Picture Compression Standard", Communications of ACM of MPEG2 the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK that are based on the principle of a block-based image encoding. According to the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK, the method of a block-based discrete cosine transformation (DCT) is employed for block-based image encoding.

Another approach for processing a digitalized image corresponding to the image encoding standard MPEG4 is what is referred to as the principle of object-based image encoding, as known from the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK.

In object-based image encoding, a segmentation of an image master into image blocks ensues corresponding to objects occurring in a scene, and a separate encoding of these objects ensues.

Components of a standard arrangement for an image encoding, as also known from the publication by W. Niem, et al., "Mapping texture from multiple

Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, and of an image decoding can be derived from Figure 7.

Figure 7 shows a camera 701 with which images are registered. The camera 701 can, for example, be an arbitrary analog camera 701 that registers images of a scene and either digitalizes the images in the camera 701 and transmits the digitalized images to a first computer 702 that is coupled to the camera 701 or transmits the images to the first computer 702 in analog form as well. In the first computer 702, the analog images are converted into digitalized images and the digitalized images are processed.

The camera 701 can also be a digital camera 701 with which directly digitalized images are registered and supplied to the first computer 702 for further processing.

The first computer 702 can also be designed as an autonomous arrangement with which the method steps described below are implemented, for example as an autonomous computer card that is installed in a further computer.

What is to be generally understood by the first computer 702 is a unit that can implement an image signal processing according to the method described below, for example a mobile terminal device (mobile telephone with a picture screen).

The first computer 702 comprises a processor unit 704 with which the method steps of the image encoding and image decoding described below are implemented. The processor unit 704, for example, is coupled via a bus 705 to a memory 706 in which an image information is stored.

In general, the methods described below can be realized both in software as well as in hardware or partly in software and partly in hardware.

After the image encoding has ensued in the first computer 701 and after the transmission of the encoded image information via a transmission medium

707 to a second computer 708, the image decoding is implemented in the second computer 708.

The second computer 708 can have the same structure as the first computer 701. The second computer 708 thus also comprises a processor 709 that is coupled to a memory 710 by a bus 711.

Figure 8 shows a possible arrangement in the form of a schematic diagram of the image encoding or, respectively, image decoding. The illustrated arrangement can be employed within the framework of a block-based image encoding and -- also shall be explained in greater detail later -- can be employed in part within the framework of an object-based image encoding.

In the block-based image encoding, a digitalized image 801 is divided into what are usually quadratic image blocks 826 having a size of 8x8 picture elements 802 or 16x16 picture elements 802 and is supplied to the arrangement 803 for image encoding.

Coding information, for example brightness information (luminance values) and/or color information (chrominance values), is usually allocated to a picture element 802.

In block-based image encoding, a distinction is made between different image encoding modes.

In what is referred to as intra-image encoding, the digitalized image 801 is respectively encoded with the coding information allocated to the picture elements 802 of the digitalized image and is transmitted.

In what is referred to as an inter-image encoding, only a difference image information of two chronologically successive, digitalized images 801 is respectively encoded and transmitted.

The difference information is very small when movements of image objects are slight in the chronologically successive, digitalized images 801. When the movements are great, then a great deal of difference information arises that is

difficult to encode. For this reason and as known from the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK, an "image-to-image" movement (motion estimate) is measured and compensated before the determination of the difference information (motion compensation).

There are different methods for the motion estimation and the motion compensation as known from the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK. What is referred to as a "block matching method" is usually utilized for the block-based image encoding. It is based thereon that an image block to be encoded is compared to reference image blocks of the same size in a reference image. The sum of the absolute differences of an encoding information that is respectively allocated to a picture element is usually employed as a criterion for a coincidence quality between the block to be encoded and a respective reference image block. In this way, a motion information for the image block is determined, for example a motion vector, this being transmitted with the difference information.

Two switch units 804 are provided for switching between the intra-image encoding and the inter-image encoding. A subtraction unit 805 wherein the difference of the image information of two chronologically successive, digitalized images 801 is formed is provided for the implementation of the inter-image encoding. The image encoding is controlled via an image encoding control unit 806. The image blocks 823 to be encoded or, respectively, difference image blocks are respectively supplied to a transformation encoding unit 807. The transformation encoding unit 807 applies a transformation encoding, for example a discrete cosine transformation (DCT), to the encoding information allocated to the picture elements 802.

In general, however, any desired transformation encoding, for example a

discrete sine transformation or a discrete Fourier transformation, can be applied for the image encoding.

Spectral coefficients (transformation coefficients) are formed by the transformation encoding. The spectral coefficients are quantized in a quantization unit 808 and are supplied to an image encoding multiplexer 821, for example to a channel encoding and/or to an entropy encoding. The quantized spectral coefficients are inversely quantized in an inverse quantization unit 809 and are subjected to an inverse transformation encoding in an inverse transformation encoding unit 810.

In the case of inter-image encoding, further, image information of the respective, chronologically preceding image are added in an adder unit 811. The images reconstructed in this way are stored in a memory 812. For simpler presentation, a unit relating to the motion compensation 813 is symbolically presented in the memory 812.

Further, a loop filter 814 is provided that is connected to the memory 812 as well as to the subtraction unit 805.

In addition to a transmitted image information 822, a mode index that respectively indicates whether an intra-image encoding or inter-image encoding was undertaken is also supplied to the image encoding multiplexer 821.

Further, quantization indices 816 for the spectral coefficients are supplied to the image encoding multiplexer 821.

A motion vector is respectively allocated to an image block 820 and/or to a macro block 823 that, for example, comprises four image blocks 820 and is supplied to the image encoding multiplexer 821.

Further, an information particular for the activation or, respectively, deactivation of the loop filter is provided. After transmission of the image information via a transmission medium 818, the decoding of the transmitted information can ensue in a second computer 819. To this end, an image decoding

unit 825 is provided in the second computer 819, this unit 825, for example, comprising the structure of a reconstruction loop of the arrangement shown in Figure 8.

The publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology discloses a shape-adapted transformation encoding is specifically applied in the framework of an object-based image encoding to edge image block or image blocks that contain only partially relevant encoding information. The edge image blocks encoded upon employment of a shape-adapted transformation encoding are characterized in that only the picture elements that are allocated to an object or, respectively, that comprise encoding information relevant to the object are encoded.

The method described in the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology is what is referred to as a shape-adapted <u>D</u>iscrete <u>C</u>osine <u>T</u>ransformation (<u>S</u>hape-<u>A</u>daptive DCT, SA-DCT).

Within the framework of an SA-DCT, the transformation coefficients allocated to an image object are defined such that picture elements of an edge image block that do not belong to the image object are blanked out. A one-dimensional DCT is then initially applied to the remaining picture elements column-by-column, the length thereof corresponding to the number of remaining picture elements in the respective column. The resulting transformation coefficients are horizontally aligned and are subsequently subject to a further one-dimensional DCT in a horizontal direction with a corresponding length.

The rule of SA-DCT known from the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology proceeds from a transformation matrix <u>DCT-N</u> having the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

N references a quantity of the image vector to be transformed wherein the transformed picture elements are contained.

<u>DCT-N</u> references a transformation matrix having the size NxN.

p, k reference indices with p, k ∈ [0, N-1].

After the SA-DCT, each column of the image block to be transformed is vertically transformed according to the rule

$$c_j = \sqrt{\frac{2}{N_j}} * [\underline{DCT-N}(p,k)] * x_j \qquad (2)$$

Subsequently, the same rule is applied to the resultant data in a horizontal direction.

Various methods for the presentation of an object on a picture screen are employed in computer graphics. One method for the presentation of a subject is what is referred to as texture mapping.

The publication by J.D. Foley et al., "Computer graphics: principles and practise" discloses such a texture mapping.

In the framework of texture mapping, a digital image that contains a brightness information (luminance values) and/or a color information (chrominance values) of the object to be presented is mapped onto a surface of a three-dimensional model of an object to be presented.

The three-dimensional model 301 of the object to be presented, the model 301 being shown in Figure 3A, is composed of a spatial, triangular grid structure 301, whereby the corner points 302 of the triangles 303 are present as points 304

of a Cartesian coordinate system 305.

As shown in Figure 3B, what is referred to as a block-shaped structure map 306 is allocated to each triangle 303, as shown in Figure 3B, the map 306 being constructed of picture elements 307 that are arranged rectangularly or, respectively, block-like. A brightness information (luminance values) and/or a color information (chrominance values) is usually allocated to each picture element 307.

The brightness or color information is allocated to the triangle 303 such that an appertaining picture element 307 of the appertaining structure map 306 is respectively allocated to a corner point 302 and 308 of the triangle 303 and 309.

The position of a corner point 308 of the triangle 309 is defined by the indication of coordinates (u_i, v_i) 310 in a two-dimensional coordinate system (u, v) 311 that is assigned to the structure map 306. The coordinates (u_i, v_i) 310 are usually normed.

Via a transformation rule (allocation or, respectively, allocation key), the corresponding point 310 in the appertaining structure map 306 is allocated to each corner point 302 of each triangle 303 of the three-dimensional model 301.

As shown in Figure 4, further, all structure maps 401 are combined into a digitalized image 402, what is referred to as a superstructure map 402, wherein the individual structure maps 401 are arranged row-by-row and column-by-column. As warranted, the structure maps 401, which contain encoding information relevant for the presentation of the object, must be supplemented with structure maps 404 that contain no encoding information that is relevant for the presentation of the subject.

In particular, however, the above-described method exhibits a disadvantage. The structure maps and the superstructure maps as well comprise picture elements that contain no brightness or color information relevant for the representation of the object.

When the superstructure map is encoded in the framework of an image transmission, then the data rate occurring in the transmission is unnecessarily increased by the non-relevant picture elements.

For improving the above method, a structure map is processed in the following way (see Figure 5):

Those picture elements 501 of a structure map 502 that contain picture elements of an encoding information relevant for the presentation of the object are transformed into a new triangular structure map 503 with picture elements 506 that are arranged in a predetermined shape -- usually a right triangle -- and in a predetermined size. The transformation is implemented such that the picture elements 501, which are corner picture elements 504 of the triangle 505, coincide with picture elements 506 that are corner picture elements 507 of the triangular structure map.

In the scope of the transformation, picture elements may potentially have to be generated by an extrapolation or an interpolation of values that contain a brightness or color information or picture elements may potentially have to be deleted.

The triangular structure map 503 thus only comprises picture elements 506 that are relevant for the presentation of an object.

As shown in Figure 6, all triangular structure maps 601 that contain brightness or color information relevant for the presentation of the object are arranged to form a new superstructure map 602.

To that end, respectively two triangular structure maps 601a and 601b are arranged to form a block-shaped structure map 603.

Further, all block-shaped structure maps 603 are grouped by rows and columns, a digitalized image being thus generated.

The publication by J.D. Foley et al., "Computer graphics: principles and practise" also discloses that such a superstructure map as generated in the

framework of a texture mapping is encoded and decoded in an image transmission.

The encoding and/or decoding of a superstructure map thereby usually ensues upon employment of a block-oriented transformation in the intra-image encoding mode, as was set forth above.

As implemented in the framework of a processing of a digital image, this procedure is not very efficient in view of a low data rate to be desired for a transmission or in view of a higher image quality.

SUMMARY OF THE INVENTION

The invention is thus based on the problem of specifying a method for processing a digitalized image and an arrangement for processing a digitalized image with which a more efficient processing of a digitalized image becomes possible.

The problems of the prior art are addressed by a method for processing a digitalized image with picture elements that contain an encoding information,

a) whereby the image is at least partially divided into image blocks;

b) whereby an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

wherein the processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block. The problems of the prior art are also addressed by an arrangement for processing a digitalized image with picture elements that contain an encoding information, whereby a processor is provided that is configured such that the following method steps can be implemented:

a) the image is at least partially divided into image blocks;

b) an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

wherein the processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

In the method for processing a digitalized image with picture elements that contain an encoding information, the image is at least partly divided into image blocks. Respectively one image block is subdivided into at least two appertaining image sub-blocks. The processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one appertaining image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

In the arrangement for processing a digitalized image having picture elements that contain an encoding information, a processor is provided that is configured such that the following method steps can be implemented:
The image is at least partially divided into image blocks. Respectively one image block is subdivided into at least two appertaining image sub-blocks. The processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one of the appertaining image sub-blocks, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with

respect to the appertaining image block.

In the method, the appertaining image block may be subdivided into a plurality of appertaining image sub-blocks. The first value, the second value and the third value are respectively allocated to each appertaining image sub-block. The image blocks may be arranged in columns and rows and/or column numbers may be assigned to the columns and row numbers are assigned to the rows. The first value of the appertaining image sub-block is the row number of the appertaining image block and the second value of the appertaining image sub-block is the column number of the appertaining image block. The appertaining image sub-blocks may exhibit a different shape than the appertaining image block. The image sub-blocks can comprise a triangular shape. Preferably, the triangular shape comprises a right angle. In the method, the appertaining image sub-blocks are modified such that the respective position of an appertaining image sub-block with respect to the appertaining image block is respectively identical. In a preferred embodiment, the method is utilized in the framework of an encoding of the image. The image sub-blocks are encoded upon employment of the encoding information and/or upon employment of the first value, the second value and the third value with a shape-adaptive transformation encoding. In one embodiment, a shape-adaptive Discrete Cosine Transformation (DCT) is utilized for the encoding. Specifically, a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) is utilized for the encoding. Further, a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is utilized for the encoding. The method may be utilized in the framework of a decoding of the image. In particular, an inverse shape-adaptive Discrete Cosine Transformation (DCT) is utilized for the decoding. Further, an inverse Shape-Adaptive Discrete Cosine Transformation (SA-DCT) is utilized for the decoding. In particular, an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is utilized for the decoding. In the method, the image at least partly comprises triangular structure maps.

The foregoing method of a preferred embodiment provides that the appertaining image block can be subdivided into a plurality of appertaining image sub-blocks. The respective first value and the respective second value and the respective third value can be allocated to each appertaining image sub-block. The arrangement can be utilized in the framework of an encoding of the image. A shape-adaptive Discrete Cosine Transformation (DCT) can be utilized for the encoding. For example, an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) can be utilized for the encoding. The arrangement can be utilized in the framework of a decoding of the image. An inverse shape-adaptive Discrete Cosine Transformation (DCT) can be utilized for the decoding. The inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) can be utilized for the decoding.

In one development, which effects a simplification of the method, the image blocks are arranged in rows and columns and/or column numbers are assigned to the columns and row numbers are assigned to the rows. The allocation expediently ensues such that the first value of the appertaining image sub-block is the row number of the appertaining image block and the second value of the appertaining image sub-block is the column number of the appertaining image block.

In another development, an image sub-block exhibits a different shape than the appertaining image block. Preferably, the shape of the image sub-block is a triangle that has a right angle. Such a shape of an image sub-block reduces the calculating outlay for a shape-adaptive transformation encoding.

The image sub-blocks are preferably combined to form the image. The image thus comprises only picture elements that contain encoding information relevant for an object.

It is also advantageous to modify the image sub-blocks such that the relative position of an image sub-block is respectively identical with respect to the

appertaining image block. A shape-adaptive transformation encoding can thus be applied in the framework of an encoding and/or an inverse transformation encoding can be applied in the framework of a decoding, being applied to all image sub-blocks of the appertaining image block.

One development is utilized in the framework of an encoding and/or decoding of the image.

It is thereby advantageous to encode the image sub-blocks with a shape-adaptive transformation encoding upon employment of the encoding information and/or upon employment of the first value, second value and third value and/or to decode the image sub-blocks with an inverse shape-adaptive transformation encoding. An efficient encoding and/or decoding of the image is thereby achieved.

A simplification derives when, in one development, a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) for encoding and/or an inverse SA-DCT for decoding is/are employed.

A further simplification derives when a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) for encoding and/or an inverse TA-DCT for decoding is/are employed.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the invention is shown in the Figures and is explained in greater detail below.

Figure 1 shows an arrangement for image encoding and image decoding with a registration of an object with a camera and a presentation of the object on a picture screen;

Figure 2 is a flow chart that illustrates the procedure for image encoding and image decoding with a registration of an object with a camera and a presentation of the object on a picture screen;

Figures 3A and 3B show a triangular grid structure of a three-dimensional model with an appertaining structure map;

Figure 4 is a schematic illustration of a superstructure map;

Figure 5 is a schematic illustration of a transformation of a structure map onto a triangular structure map;

Figure 6 is a schematic illustration of a superstructure map composed of triangular structure maps;

Figure 7 is a functional block diagram of arrangement for image encoding or, respectively, image decoding with a camera, two computers and a transmission medium;

Figure 8 is a functional block diagram of an arrangement for block-based image encoding or, respectively, image decoding;

Figure 9 is an illustration of the resolution of the block-shaped structure map.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows an arrangement for an image encoding and an image decoding with a registration of an object with a camera and a presentation of the object on a picture screen.

Figure 1 shows a camera 101 with which images of an object 152 are registered. The camera 101 is an analog color camera that registers images of the object 152 and transmits the images to a first computer 102 in analog form. In the first computer 102, the analog images are converted into digitalized images, whereby picture elements of the digitalized images contain color information of the object 152, and the digitalized images are processed.

The object 152 is arranged centered on an object carrier 153. The relative position of the object carrier 153 with respect to the camera 101 is permanently prescribed. By rotating the object carrier 153 around its center, the object 152 can

be moved such that the angle of view from which the camera 101 registers the object 152 changes continuously given an unmodified distance of the object 152 from the camera 101.

The first computer 102 is configured as an autonomous arrangement in the form of an autonomous computer card that is installed in the first computer 102, the method steps described below being implemented with the computer card.

The first computer 102 comprises a processor 104 with which the method steps of image encoding described below are implemented. The processor unit 104 is coupled via a bus 105 to a memory 106 in which image information is stored.

The method for image encoding described below is realized in software. It is stored in the memory 106 and is implemented by the processor 104.

After the image encoding has ensued in the first computer 101 and after a transmission of the encoded image information via a transmission medium 107 to a second computer 108, the image decoding is implemented in the second computer 108. Subsequently, a model of the object 152 is presented on a picture screen 155 linked to the second computer 108 upon employment of the decoded image information of the object 152.

The second computer 108 has the same structure as the first computer 101. The second computer 108 also comprises a processor 109, the processor being coupled to a memory 110 with a bus 111.

The method described below for the image decoding is realized in software. It is stored in the memory 110 and is implemented by the processor 109.

Figure 2 schematically shows the procedure for a processing of a digitalized image in the framework of an encoding and of a decoding with a registration of an object with a camera and a presentation of the object on a picture screen.

This procedure for the encoding and the decoding is realized by the arrangement shown in Figure 1 and described above.

1st Step Registration of the Object (201)

Upon employment of the camera 101 as described in the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, images of the object 152 are registered, said object 152 being rotated in its position relative to the camera 101 in predetermined rotational angles with the object carrier 153. The images are transmitted to the first computer 102 in analog form.

Before the implementation of the registration of the object 152, the camera 101 is calibrated, as described in the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, whereby a spatial geometry of the arrangement as well as the exposure parameters of the camera 101, for example the focal length of the camera 101, are defined.

The geometry data as well as the camera parameters are transmitted to the first computer 102.

2. Digitalizing the Images (202)

The analog images are converted into digitalized images in the first computer 102 and the digitalized images are processed.

3. Image Processing (203)

The processing of the digitalized images 103 ensues according to the method of automatic three-dimensional modeling upon employment of a plurality of images of the object, as described in the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging.

Two method steps are implemented in the framework of the method of automatic three-dimensional modeling upon employment of a plurality of images of an object:

In the first step of the method, a volume model 301 of the object 152 is determined with a method for determining a contour of an object in a digitalized image, as cited in the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, upon employment of the camera parameters and of the digitalized images 103.

The volume model 301 of the object 152, as shown in Figure 3, is composed of a spatial, triangular grid structure 301, whereby the corner points 302 of the triangles 303 are present as points 304 of a Cartesian coordinate system 305.

In the second step of the method, what is referred to as a structure map 306 is determined for each triangle 303 upon employment of the digitalized images 103 as well as of the color information contained in picture elements of the digitalized images 103.

The structure map is constructed of picture elements 307 arranged block-like. Each picture element 307 contains a color information (chrominance values) of the object 152.

The color information is allocated to the triangle 303 in that an

appertaining picture element 307 of the appertaining structure map 306 is respectively allocated to a corner point 302 and 308 of the triangle 303 and 309.

The position of the corner points 308 of the triangle 309 is determined by the specification of coordinates (u_i, v_i) 310 in a two-dimensional coordinate system (u, v) 311 that is allocated to the structure map 306. The coordinates (u_i, v_i) 310 are subsequently normed.

Via a transformation rule, the corresponding point 310 in the appertaining structure map 306 is assigned to each corner point 302 of each triangle 303 of the three-dimensional model 301.

Those picture elements 501 of a structure map that contain a color information relevant for the presentation of the object 152 are transformed into a new triangular structure map 503. The picture elements 506 of the triangular structure map are arranged such that they form a right-angle and equilateral triangle, whereby one side comprises five picture elements. The transformation is implemented such that the picture elements 501 that are corner picture elements 504 of the triangle 505 coincide with picture elements 506 that are corner picture elements 507 of the triangular structure map 503.

In the framework of the transformation, picture elements may potentially have to be generated by an extrapolation or an interpolation of values that contain color information or picture elements may potentially have to be deleted.

The triangular structure map 503 thus comprises only picture elements 506 that are relevant for the presentation of an object.

As shown in Figure 6, all triangular structure maps 601 that contain the color information relevant for the presentation of the object are arranged to form a new superstructure map 602.

To that end, respectively two triangular structure maps 601 are arranged to form a block-shaped structure map 603. Further, all block-shaped structure maps 603 are groups by rows and columns, whereby a digitalized image is generated.

Due to the uniform and predetermined shape of the triangular structure map, the row-by-row and column-by-column arrangement of the block-shaped structure maps 603 and a predetermined size of the superstructure map 602, a simplified transformation rule or, respectively, a simplified allocation key derives that is referred to as texture binding:

Each triangle 303 of the spatial triangular grid structure 301 of the three-dimensional model of the object 152 has allocated to it a first value n_S that indicates the column number of the triangular structure map 601 belonging to the triangle 303 within the superstructure map 602, a second value n_Z that indicates the row number of the triangular structure map 601 belonging to the triangle 303 within the superstructure map 602, and a third value n_L that indicates the relative position of the triangular structure map 601a or, respectively, 601b with respect to the block-shaped structure map 603.

Upon employment of the value triad (n_S, n_Z, n_L) indicated for each triangle 303 of the spatial grid structure 301 and of the given values in view of the height H (plurality of picture elements, for example 80 picture elements) of the superstructure map having the size HxB and of the given plurality of picture elements Z arranged in a side of the right equilateral triangle with, for example, Z=5 picture elements, an allocation of a triangular structure map 601 of the superstructure map 602 to the appertaining triangle 303 of the volume model 301 of the object is determined according to the following relationships:

$A_x = (Z/B) * (n_S-1)$

$A_y = (Z/H) * (n_Z-1)$

$B_x = (Z/B) * n_S$

$B_y = A_y$

$C_x = B_x$

$C_y = (Z/H) * n_Z$

$D_x = A_x$

$D_y = C$

The corner picture elements (Ax,Ay), (Cx,Cy) and (Dx,Dy) are relevant for the value nL = 0 that describes a triangular structure map 601a arranged at the left within the block-shaped structure map 603.

The corner points (A_x,A_y), $C_x,C_y)$ and (B_x,B_y) are relevant for the value $n_L = 1$ that describes a triangular structure map 601b arranged at the left within the block-shaped structure map 603.

The two values that are identified by the index x and by the index y thereby indicate the coordinates of a point of the superstructure map 602 with respect to a Cartesian coordinate system 610 that is arranged in the upper left corner 611 of the superstructure map 602.

4. Encoding (204)

What is referred to as a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is employed for the encoding of the superstructure map 602. This method for encoding a digitalized image is based on the method of a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) as described in] the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology.

In the framework of a TA-DCT, the transformation coefficients allocated to an image object are defined such that picture elements of an edge image block that do nor belong to the image object are blanked out. A one-dimensional DCT, whose length corresponds to the number of picture elements remaining in the respective column, is then first applied column-by-column to the remaining picture elements. The resulting transformation coefficients are subsequently subjected to a further one-dimensional DCT in horizontal direction with a corresponding length.

The method of TA-DCT proceeds from a transformation matrix DCT-N

having the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p*\left(k+\frac{1}{2}\right)*\frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

N references a quantity of the image vector to be transformed wherein the transformed picture elements are contained.

DCT-N references a transformation matrix having the size NxN.

p, k reference indices with p, k ∈ [0, N-1].

After the TA-DCT, each column of the image block to be transformed is vertically transformed according to the rule

$$c_j = \sqrt{\frac{2}{N_j}} * [\underline{DCT-N}(p,k)] * x_j \qquad (2)$$

Subsequently, the same rule is applied to the resultant data in horizontal direction.

In the framework of the encoding of a superstructure map 602 upon employment of TA-DCT, the superstructure map 62 is subdivided into the block-shaped structure maps 603. A block-shaped structure map 603 and 901 is thereby divided into a first new block-shaped structure map 902 and a second new block-shaped structure map 903, as shown in Figure 9, in that the picture elements of the second triangular structure map 601b and 904 are deleted for the determination of the first new block-shaped structure map 602. The second new block-shaped structure map 903 is determined in that the picture elements of the first triangular structure map 601a and 905 are deleted.

Further, the second new block-shaped structure map 903 is modified such by shifting picture elements 906 that the relative position of the picture elements 906 of the second block-shaped structure map 903 with respect to the second new

block-shaped structure map 903 coincides with the relative position of the picture elements 907 of the first new block-shaped structure map 902 with respect to the first new block-shaped structure map 902.

The TA-DCT can thus be correspondingly applied to the first new block-shaped structure map 902 and to the second new block-shaped structure map 903.

The TA-DCT can be utilized due to the specific relative position of the picture elements 906 and 907 with respect to the first new block-shaped structure map 902 and the second new block-shaped structure map 903.

5. Transmission (205)

The image information (image information of the superstructure map) encoded upon employment of the TA-DCT is transmitted via a transmission medium 107 to the second computer 108 together with data of the volume model of the object as well as of the allocation $(n_S, n_Z, n_L)_i$ ($i = 1 \ldots N$, with N = number of triangles of the grid structure of the volume model).

6. Decoding (206)

An image decoding is implemented after transmission of the encoded image information.

To that end, the spectral coefficients c_j are supplied to an inverse TA-DCT.

Given inverse TA-DCT in the framework if image encoding in the intra-image encoding mode, picture elements x_j are formed from the spectral coefficients c_j according to the following rule (4):

$$x_j = \sqrt{\frac{2}{N}} * [\underline{DCT - N}(p,k)]^{-1} * c_j \qquad (4)$$

whereby the transformation matrix DCT-N comprises the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

whereby

-- N references a size of the image vector to be transformed wherein the picture elements to be transformed are contained;

-- [DCT-N (p, k)] references a transformation matrix having the size NxN;

-- p, k reference indices with p, k ∈ [0, N-1];

-- $( )^{-1}$ references an inversion of a matrix.

The decoded image or, respectively, the superstructure map 602 is determined upon employment of the determined picture elements x_j.

7. Presentation of the Object (207)

The model of the object 152 is presented on the picture screen 108 upon employment of the superstructure map, the data of the volume model of the object 152 as well as the allocation$(n_S, n_Z, n_L)_i$ (i = 1 ... N, with N = number of triangles of the grid structure of the volume model), as described in the Internet publication PANORAMA technical Support, available on 12 October 1998 at: http://www.tnt.uni-hannover.de/project/eu/panorama/TS.html.

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.

IN THE CLAIMS

The claims have been amended as follows:

I claim:

1. (Amended) A method for processing a digitalized image with picture elements that contain an encoding information, comprising the steps of:

dividing the image is at least partially into image blocks;

subdividing an appertaining image block respectively into at least two appertaining image sub-blocks;

implementing processing of the image such that a first value and a second value and a third value are respectively allocated to at least one image sub-block, the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

2. (Amended) A method according to claim 1, wherein said step of subdividing provides that the appertaining image block is subdivided into a plurality of appertaining image sub-blocks.

3. (Amended) A method according to claim 1, wherein said step of implementing provides that the first value and the second value and the third value are respectively allocated to each appertaining image sub-block.

4. (Amended) A method according to claim 1, wherein the image blocks are arranged in columns and rows.

5. (Amended) A method according to claim 29, wherein a first value of the appertaining image sub-block is the row number of the appertaining image block

and a second value of the appertaining image sub-block is the column number of the appertaining image block.

6. (Amended) A method according to claim 1, wherein the appertaining image sub-blocks exhibit a different shape than the appertaining image block.

7. (Amended) A method according to claim 1, wherein the image sub-blocks are of a triangular shape.

8. (Amended) A method according to claim 7, wherein the triangular shape includes a right angle.

9. (Amended) A method according to claim 1, further comprising the step of:

modifying the appertaining image sub-blocks such that the respective position of an appertaining image sub-block with respect to the appertaining image block is respectively identical.

10. (Amended) A method according to claim 1, further comprising the step of:

utilizing the steps for encoding of the image.

11. (Amended) A method according to claim 10, further comprising the steps of:

encoding the image sub-blocks upon employment of the encoding information with a shape-adaptive transformation encoding.

12. (Amended) A method according to claim 11, wherein a shape-adaptive

Discrete Cosine Transformation is utilized for the encoding.

13. (Amended) A method according to claim 12, wherein a Shape-Adaptive Discrete Cosine Transformation is utilized for the encoding.

14. (Amended) A method according to claim 13, wherein a Triangle-Adaptive Discrete Cosine Transformation is utilized for the encoding.

15. (Amended) A method according to claim 1, wherein the steps are utilized in the framework of a decoding of the image.

16. (Amended) A method according to claim 15, wherein an inverse shape-adaptive Discrete Cosine Transformation is utilized for the decoding.

17. (Amended) A method according to claim 16, wherein an inverse Shape-Adaptive Discrete Cosine Transformation is utilized for the decoding.

18. (Amended) A method according to claim 17, wherein an inverse Triangle-Adaptive Discrete Cosine Transformation is utilized for the decoding.

19. (Amended) A method according to claim 1, wherein the image at least partly includes triangular structure maps.

20. (Amended) An arrangement for processing a digitalized image with picture elements that contain an encoding information, comprising:
a processor that is configured such that the following method steps can be implemented:

the image is at least partially divided into image blocks;

an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

the processing of the image is implemented such that a first value and a second value and a third value are respectively allocated to at least one image sub-block, the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

21. (Amended) An arrangement according to claim 20, wherein the appertaining image block is subdivided into a plurality of appertaining image sub-blocks.

22. (Amended) An arrangement according to claim 20, wherein the respective first value and the respective second value and the respective third value are allocated to each appertaining image sub-block.

23. (Amended) An arrangement according to claim 20, wherein the processor is utilized in an encoding of the image.

24. (Amended) An arrangement according to claim 23, wherein a shape-adaptive Discrete Cosine Transformation is utilized for the encoding.

25. (Amended) An arrangement according to claim 24, wherein an inverse Triangle-Adaptive Discrete Cosine Transformation is utilized for the encoding.

26. (Amended) An arrangement according to claim 20, wherein the processor is utilized in the framework of a decoding of the image.

27. (Amended) An arrangement according to claim 26, wherein an inverse shape-adaptive Discrete Cosine Transformation is utilized for the decoding.

28. (Amended) An arrangement according to claim 27, wherein an inverse Triangle-Adaptive Discrete Cosine Transformation is utilized for the decoding.

29. A method according to claim 1, further comprising the step of: assigning column numbers to the columns and row numbers to the rows.

30. A method according to claim 10, further comprising the steps of: encoding the image sub-blocks upon employment of the first value and the second value and the third value with a shape-adaptive transformation encoding.

IN THE ABSTRACT

The abstract has been amended as follows:

Abstract of the Disclosure

Methods and arrangements are recited for processing a digitalized image with picture elements that contain an encoding information. To that end, the image is divided into image blocks and a respective image block is divided into two image sub-blocks. The processing of the image is implemented such that a respective first value and a respective second value and a respective third value is allocated to an image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block. Further, the employment of the method and of the arrangement in the framework of an encoding and decoding is recited.

REMARKS

The foregoing amendments to the specification and claims under Article 41 of the Patent Cooperation Treaty place the application into a form for prosecution before the U.S. Patent and Trademark Office under 35 U.S.C. §371. Accordingly, entry of these amendments before examination on the merits is hereby requested.

Respectfully submitted,

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VERSION MARKED TO SHOW CHANGES

The marked up version showing the amendments follows:

SPECIFICATION

TITLE

METHOD AND ARRANGEMENT FOR PROCESSING A DIGITALIZED IMAGE

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention is directed to an arrangement and to a method for processing a digitalized image as utilized and implemented in the framework of an encoding and decoding of a digitalized image.

Such a method and such an arrangement are utilized in the framework of an encoding and decoding of a digitalized image corresponding to one of the image encoding standards H.261 [~~1~~] the publication by D. Le Gall, "The Video Compression Standard for Multimedia Applications", Communications of ACM, H.263 [~~2~~] the publication by G. Wallace, "The JPEG Still Picture Compression Standard", Communications of ACM of MPEG2 [~~3~~] the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK that are based on the principle of a block-based image encoding. According to [~~3~~] the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK, the method of a block-based discrete cosine transformation (DCT) is employed for block-based image encoding.

Another approach for processing a digitalized image corresponding to the image encoding standard MPEG4 is what is referred to as the principle of object-based image encoding, as known from [~~3~~] the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK.

In object-based image encoding, a segmentation of an image master into image blocks ensues corresponding to objects occurring in a scene, and a separate encoding of these objects ensues.

Components of a standard arrangement for an image encoding, as also known from [[~~7~~]] the publication by W. Niem, et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, and of an image decoding can be derived from Figure 7.

Figure 7 shows a camera 701 with which images are registered. The camera 701 can, for example, be an arbitrary analog camera 701 that registers images of a scene and either digitalizes the images in the camera 701 and transmits the digitalized images to a first computer 702 that is coupled to the camera 701 or transmits the images to the first computer 702 in analog form as well. In the first computer 702, the analog images are converted into digitalized images and the digitalized images are processed.

The camera 701 can also be a digital camera 701 with which directly digitalized images are registered and supplied to the first computer 702 for further processing.

The first computer 702 can also be designed as an autonomous arrangement with which the method steps described below are implemented, for example as an autonomous computer card that is installed in a further computer.

What is to be generally understood by the first computer 702 is a unit that can implement an image signal processing according to the method described below, for example a mobile terminal device (mobile telephone with a picture screen).

The first computer 702 comprises a processor unit 704 with which the method steps of the image encoding and image decoding described below are implemented. The processor unit 704, for example, is coupled via a bus 705 to a

memory 706 in which an image information is stored.

In general, the methods described below can be realized both in software as well as in hardware or partly in software and partly in hardware.

After the image encoding has ensued in the first computer 701 and after the transmission of the encoded image information via a transmission medium 707 to a second computer 708, the image decoding is implemented in the second computer 708.

The second computer 708 can have the same structure as the first computer 701. The second computer 708 thus also comprises a processor 709 that is coupled to a memory 710 by a bus 711.

Figure 8 shows a possible arrangement in the form of a schematic diagram of the image encoding or, respectively, image decoding. The illustrated arrangement can be employed within the framework of a block-based image encoding and -- also shall be explained in greater detail later -- can be employed in part within the framework of an object-based image encoding.

In the block-based image encoding, a digitalized image 801 is divided into what are usually quadratic image blocks [~~820~~] 826 having a size of 8x8 picture elements 802 or 16x16 picture elements 802 and is supplied to the arrangement 803 for image encoding.

Coding information, for example brightness information (luminance values) and/or color information (chrominance values), is usually allocated to a picture element 802.

In block-based image encoding, a distinction is made between different image encoding modes.

In what is referred to as intra-image encoding, the digitalized image 801 is respectively encoded with the coding information allocated to the picture elements 802 of the digitalized image and is transmitted.

In what is referred to as an inter-image encoding, only a difference image

information of two chronologically successive, digitalized images 801 is respectively encoded and transmitted.

The difference information is very small when movements of image objects are slight in the chronologically successive, digitalized images 801. When the movements are great, then a great deal of difference information arises that is difficult to encode. For this reason and as known from [~~[3]~~] the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK, an "image-to-image" movement (motion estimate) is measured and compensated before the determination of the difference information (motion compensation).

There are different methods for the motion estimation and the motion compensation as known from [~~[3]~~] the publication by De Lameillieure, J. et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK. What is referred to as a "block matching method" is usually utilized for the block-based image encoding. It is based thereon that an image block to be encoded is compared to reference image blocks of the same size in a reference image. The sum of the absolute differences of an encoding information that is respectively allocated to a picture element is usually employed as a criterion for a coincidence quality between the block to be encoded and a respective reference image block. In this way, a motion information for the image block is determined, for example a motion vector, this being transmitted with the difference information.

Two switch units 804 are provided for switching between the intra-image encoding and the inter-image encoding. A subtraction unit 805 wherein the difference of the image information of two chronologically successive, digitalized images 801 is formed is provided for the implementation of the inter-image encoding. The image encoding is controlled via an image encoding control unit 806. The image blocks [~~820~~] 823 to be encoded or, respectively, difference image

blocks are respectively supplied to a transformation encoding unit 807. The transformation encoding unit 807 applies a transformation encoding, for example a discrete cosine transformation (DCT), to the encoding information allocated to the picture elements 802.

In general, however, any desired transformation encoding, for example a discrete sine transformation or a discrete Fourier transformation, can be applied for the image encoding.

Spectral coefficients (transformation coefficients) are formed by the transformation encoding. The spectral coefficients are quantized in a quantization unit 808 and are supplied to an image encoding multiplexer 821, for example to a channel encoding and/or to an entropy encoding. The quantized spectral coefficients are inversely quantized in an inverse quantization unit 809 and are subjected to an inverse transformation encoding in an inverse transformation encoding unit 810.

In the case of inter-image encoding, further, image information of the respective, chronologically preceding image are added in an adder unit 811. The images reconstructed in this way are stored in a memory 812. For simpler presentation, a unit relating to the motion compensation 813 is symbolically presented in the memory 812.

Further, a loop filter 814 is provided that is connected to the memory 812 as well as to the subtraction unit 805.

In addition to a transmitted image information 822, a mode index that respectively indicates whether an intra-image encoding or inter-image encoding was undertaken is also supplied to the image encoding multiplexer 821.

Further, quantization indices 816 for the spectral coefficients are supplied to the image encoding multiplexer 821.

A motion vector is respectively allocated to an image block 820 and/or to a macro block 823 that, for example, comprises four image blocks 820 and is

supplied to the image encoding multiplexer 821.

Further, an information particular for the activation or, respectively, deactivation of the loop filter is provided. After transmission of the image information via a transmission medium 818, the decoding of the transmitted information can ensue in a second computer 819. To this end, an image decoding unit 825 is provided in the second computer 819, this unit 825, for example, comprising the structure of a reconstruction loop of the arrangement shown in Figure 8.

[~~[4]~~] The publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology discloses a shape-adapted transformation encoding is specifically applied in the framework of an object-based image encoding to edge image block or image blocks that contain only partially relevant encoding information. The edge image blocks encoded upon employment of a shape-adapted transformation encoding are characterized in that only the picture elements that are allocated to an object or, respectively, that comprise encoding information relevant to the object are encoded.

The method described in [~~[4]~~] the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology is what is referred to as a shape-adapted Discrete Cosine Transformation (Shape-Adaptive DCT, SA-DCT).

Within the framework of an SA-DCT, the transformation coefficients allocated to an image object are defined such that picture elements of an edge image block that do not belong to the image object are blanked out. A one-dimensional DCT is then initially applied to the remaining picture elements column-by-column, the length thereof corresponding to the number of remaining picture elements in the respective column. The resulting transformation coefficients are horizontally aligned and are [~~a~~] subsequently subject to [~~in [sic]~~] a

further one-dimensional DCT in a horizontal direction with a corresponding length.

The rule of SA-DCT known from [[~~4~~]] the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology proceeds from a transformation matrix DCT-N having the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

N references a quantity of the image vector to be transformed wherein the transformed picture elements are contained.

DCT-N references a transformation matrix having the size NxN.

p, k reference indices with p, k ∈ [0, N-1].

After the SA-DCT, each column of the image block to be transformed is vertically transformed according to the rule

$$c_j = \sqrt{\frac{2}{N_j}} * [\underline{DCT-N}(p,k)] * x_j \qquad (2)$$

Subsequently, the same rule is applied to the resultant data in a horizontal direction.

Various methods for the presentation of an object on a picture screen are employed in computer graphics. One method for the presentation of a subject is what is referred to as texture mapping.

[[~~5~~]] the publication by J.D. Foley et al., "Computer graphics: principles and practise" discloses such a texture mapping.

In the framework of texture mapping, a digital image that contains a

brightness information (luminance values) and/or a color information (chrominance values) of the object to be presented is mapped onto a surface of a three-dimensional model of an object to be presented.

The three-dimensional model 301 of the object to be presented, [~~said~~] the model 301 being shown in Figure 3A, is composed of a spatial, triangular grid structure 301, whereby the corner points 302 of the triangles 303 are present as points 304 of a Cartesian coordinate system 305.

As shown in Figure 3B, what is referred to as a block-shaped structure map 306 is allocated to each triangle 303, as shown in Figure 3B, [~~said~~] the map 306 being constructed of picture elements 307 that are arranged rectangularly or, respectively, block-like. A brightness information (luminance values) and/or a color information (chrominance values) is usually allocated to each picture element 307.

The brightness or color information is allocated to the triangle 303 such that an appertaining picture element 307 of the appertaining structure map 306 is respectively allocated to a corner point 302 and 308 of the triangle 303 and 309.

The position of a corner point 308 of the triangle 309 is defined by the indication of coordinates (u_i, v_i) 310 in a two-dimensional coordinate system (u, v) 311 that is assigned to the structure map 306. The coordinates (u_i, v_i) 310 are usually normed.

Via a transformation rule (allocation or, respectively, allocation key), the corresponding point 310 in the appertaining structure map 306 is allocated to each corner point 302 of each triangle 303 of the three-dimensional model 301.

As shown in Figure 4, further, all structure maps 401 are combined into a digitalized image 402, what is referred to as a superstructure map 402, wherein the individual structure maps 401 are arranged row-by-row and column-by-column. As warranted, the structure maps 401, which contain encoding information relevant for the presentation of the object, must be supplemented with

structure maps 404 that contain no encoding information that is relevant for the presentation of the subject.

In particular, however, the above-described method exhibits a disadvantage. The structure maps and the superstructure maps as well comprise picture elements that contain no brightness or color information relevant for the representation of the object.

When the superstructure map is encoded in the framework of an image transmission, then the data rate occurring in the transmission is unnecessarily increased by the non-relevant picture elements.

For improving the above method, a structure map is processed in the following way (see Figure 5):

Those picture elements 501 of a structure map 502 that contain picture elements [[~~[...]~~]] of an encoding information relevant for the presentation of the object are transformed into a new triangular structure map 503 with picture elements 506 that are arranged in a predetermined shape -- usually a right triangle -- and in a predetermined size. The transformation is implemented such that the picture elements 501, which are corner picture elements 504 of the triangle 505, coincide with picture elements 506 that are corner picture elements 507 of the triangular structure map.

In the scope of the transformation, picture elements may potentially have to be generated by an extrapolation or an interpolation of values that contain a brightness or color information or picture elements may potentially have to be deleted.

The triangular structure map 503 thus only comprises picture elements 506 that are relevant for the presentation of an object.

As shown in Figure 6, all triangular structure maps 601 that contain brightness or color information relevant for the presentation of the object are arranged to form a new superstructure map 602.

To that end, respectively two triangular structure maps 601a and 601b are arranged to form a block-shaped structure map 603.

Further, all block-shaped structure maps 603 are grouped by rows and columns, a digitalized image being thus generated.

[~~[5]~~] the publication by J.D. Foley et al., "Computer graphics: principles and practise" also discloses that such a superstructure map as generated in the framework of a texture mapping is encoded and decoded in an image transmission.

The encoding and/or decoding of a superstructure map thereby usually ensues upon employment of a block-oriented transformation in the intra-image encoding mode, as was set forth above.

As implemented in the framework of a processing of a digital image, this procedure is not very efficient in view of a low data rate to be desired for a transmission or in view of a higher image quality.

SUMMARY OF THE INVENTION

The invention is thus based on the problem of specifying a method for processing a digitalized image and an arrangement for processing a digitalized image with which a more efficient processing of a digitalized image becomes possible.

[~~The problem is solved by the method comprising the features according to the independent claims as well as by the arrangements comprising the features according to the independent claims.~~]

The problems of the prior art are addressed by a method for processing a digitalized image with picture elements that contain an encoding information,

a) whereby the image is at least partially divided into image blocks;

b) whereby an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

wherein the processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block. The problems of the prior art are also addressed by an arrangement for processing a digitalized image with picture elements that contain an encoding information, whereby a processor is provided that is configured such that the following method steps can be implemented:

a) the image is at least partially divided into image blocks;

b) an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

wherein the processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

In the method for processing a digitalized image with picture elements that contain an encoding information, the image is at least partly divided into image blocks. Respectively one image block is subdivided into at least two appertaining image sub-blocks. The processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one appertaining image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

In the arrangement for processing a digitalized image having picture

elements that contain an encoding information, a processor is provided that is configured such that the following method steps can be implemented:
The image is at least partially divided into image blocks. Respectively one image block is subdivided into at least two appertaining image sub-blocks. The processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one of the appertaining image sub-blocks, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

[~~Preferred developments of the invention derive from the dependent claims.~~]

In the method, the appertaining image block may be subdivided into a plurality of appertaining image sub-blocks. The first value, the second value and the third value are respectively allocated to each appertaining image sub-block. The image blocks may be arranged in columns and rows and/or column numbers may be assigned to the columns and row numbers are assigned to the rows. The first value of the appertaining image sub-block is the row number of the appertaining image block and the second value of the appertaining image sub-block is the column number of the appertaining image block. The appertaining image sub-blocks may exhibit a different shape than the appertaining image block. The image sub-blocks can comprise a triangular shape. Preferably, the triangular shape comprises a right angle. In the method, the appertaining image sub-blocks are modified such that the respective position of an appertaining image sub-block with respect to the appertaining image block is respectively identical. In a preferred embodiment, the method is utilized in the framework of an encoding of the image. The image sub-blocks are encoded upon employment of the encoding information and/or upon employment of the first value, the second value and the

third value with a shape-adaptive transformation encoding. In one embodiment, a shape-adaptive Discrete Cosine Transformation (DCT) is utilized for the encoding. Specifically, a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) is utilized for the encoding. Further, a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is utilized for the encoding. The method may be utilized in the framework of a decoding of the image. In particular, an inverse shape-adaptive Discrete Cosine Transformation (DCT) is utilized for the decoding. Further, an inverse Shape-Adaptive Discrete Cosine Transformation (SA-DCT) is utilized for the decoding. In particular, an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is utilized for the decoding. In the method, the image at least partly comprises triangular structure maps.

The foregoing method of a preferred embodiment provides that the appertaining image block can be subdivided into a plurality of appertaining image sub-blocks. The respective first value and the respective second value and the respective third value can be allocated to each appertaining image sub-block. The arrangement can be utilized in the framework of an encoding of the image. A shape-adaptive Discrete Cosine Transformation (DCT) can be utilized for the encoding. For example, an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) can be utilized for the encoding. The arrangement can be utilized in the framework of a decoding of the image. An inverse shape-adaptive Discrete Cosine Transformation (DCT) can be utilized for the decoding. The inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) can be utilized for the decoding.

In one development, which effects a simplification of the method, the image blocks are arranged in rows and columns and/or column numbers are assigned to the columns and row numbers are assigned to the rows. The allocation expediently ensues such that the first value of the appertaining image sub-block is the row number of the appertaining image block and the second value

of the appertaining image sub-block is the column number of the appertaining image block.

In another development, an image sub-block exhibits a different shape than the appertaining image block. Preferably, the shape of the image sub-block is a triangle that has a right angle. Such a shape of an image sub-block reduces the calculating outlay for a shape-adaptive transformation encoding.

The image sub-blocks are preferably combined to form the image. The image thus comprises only picture elements that contain encoding information relevant for an object.

It is also advantageous to modify the image sub-blocks such that the relative position of an image sub-block is respectively identical with respect to the appertaining image block. A shape-adaptive transformation encoding can thus be applied in the framework of an encoding and/or an inverse transformation encoding can be applied in the framework of a decoding, being applied to all image sub-blocks of the appertaining image block.

One development is utilized in the framework of an encoding and/or decoding of the image.

It is thereby advantageous to encode the image sub-blocks with a shape-adaptive transformation encoding upon employment of the encoding information and/or upon employment of the first value, second value and third value and/or to decode the image sub-blocks with an inverse shape-adaptive transformation encoding. An efficient encoding and/or decoding of the image is thereby achieved.

A simplification derives when, in one development, a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) for encoding and/or an inverse SA-DCT for decoding is/are employed.

A further simplification derives when a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) for encoding and/or an inverse TA-DCT for decoding

is/are employed.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the invention is shown in the Figures and is explained in greater detail below.

[~~Shown are:~~]

Figure 1 shows an arrangement for image encoding and image decoding with a registration of an object with a camera and a presentation of the object on a picture screen;

Figure 2 is a flow chart that illustrates [~~schematic illustration of~~] the procedure for image encoding and image decoding with a registration of an object with a camera and a presentation of the object on a picture screen;

Figures 3A and 3B show a triangular grid structure of a three-dimensional model with an appertaining structure map;

Figure 4 is a schematic illustration of a superstructure map;

Figure 5 is a schematic illustration of a transformation of a structure map onto a triangular structure map;

Figure 6 is a schematic illustration of a superstructure map composed of triangular structure maps;

Figure 7 is a functional block diagram of arrangement for image encoding or, respectively, image decoding with a camera, two computers and a transmission medium;

Figure 8 is a functional block diagram [~~sketch~~] of an arrangement for block-based image encoding or, respectively, image decoding;

Figure 9 is an illustration of the resolution of the block-shaped structure map.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows an arrangement for an image encoding and an image decoding with a registration of an object with a camera and a presentation of the object on a picture screen.

Figure 1 shows a camera 101 with which images of an object 152 are registered. The camera 101 is an analog color camera that registers images of the object 152 and transmits the images to a first computer 102 in analog form. [~~in~~] In the first computer 102, the analog images are converted into digitalized images, whereby picture elements of the digitalized images contain [~~a~~] color information of the object 152, and the digitalized images are processed.

The object 152 is arranged centered on an object carrier 153. The relative position of the object carrier 153 with respect to the camera 101 is permanently prescribed. By rotating the object carrier 153 around its center, the object 152 can be moved such that the angle of view from which the camera 101 registers the object 152 changes continuously given an unmodified distance of the object 152 from the camera 101.

The first computer 102 is configured as an autonomous arrangement in the form of an autonomous computer card that is installed in the first computer 102, the method steps described below being implemented with [~~said~~] the computer card.

The first computer 102 comprises a processor 104 with which the method steps of image encoding described below are implemented. The processor unit 104 is coupled via a bus 105 to a memory 106 in which [~~an~~] image information is stored.

The method for image encoding described below is realized in software. It is stored in the memory 106 and is implemented by the processor 104.

After the image encoding has ensued in the first computer 101 and after a transmission of the encoded image information via a transmission medium 107 to a second computer 108, the image decoding is implemented in the second

computer 108. Subsequently, a model of the object 152 is presented on a picture screen 155 linked to the second computer 108 upon employment of the decoded image information of the object 152.

The second computer 108 has the same structure as the first computer 101. The second computer 108 also comprises a processor 109, [~~said~~] the processor being coupled to a memory 110 with a bus 111.

The method described below for the image decoding is realized in software. It is stored in the memory 110 and is implemented by the processor 109.

Figure 2 schematically shows the procedure for a processing of a digitalized image in the framework of an encoding and of a decoding with a registration of an object with a camera and a presentation of the object on a picture screen.

This procedure for the encoding and the decoding is realized by the arrangement shown in Figure 1 and described above.

1st Step Registration of the Object (201)

Upon employment of the camera 101 as described in [[~~7~~]] the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, images of the object 152 are registered, said object 152 being rotated in its position relative to the camera 101 in predetermined rotational angles with the object carrier 153. The images are transmitted to the first computer 102 in analog form.

Before the implementation of the registration of the object 152, the camera 101 is calibrated, as described in [[~~7~~]] the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and

Three Dimensional Imaging, whereby a spatial geometry of the arrangement as well as the exposure parameters of the camera 101, for example the focal length of the camera 101, are defined.

The geometry data as well as the camera parameters are transmitted to the first computer 102.

2. Digitalizing the Images (202)

The analog images are converted into digitalized images in the first computer 102 and the digitalized images are processed.

3. Image Processing (203)

The processing of the digitalized images 103 ensues according to the method of automatic three-dimensional modeling upon employment of a plurality of images of the object, as described in [[~~7~~]] the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging.

Two method steps are implemented in the framework of the method of automatic three-dimensional modeling upon employment of a plurality of images of an object:

In the first step of the method, a volume model 301 of the object 152 is determined with a method for determining a contour of an object in a digitalized image, as cited in [[~~7~~]] the publication by W. Niem et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, upon employment of the camera parameters and of the digitalized images 103.

The volume model 301 of the object 152, as shown in Figure 3, is composed of a spatial, triangular grid structure 301, whereby the corner points 302 of the triangles 303 are present as points 304 of a Cartesian coordinate system 305.

In the second step of the method, what is referred to as a structure map 306 is determined for each triangle 303 upon employment of the digitalized images 103 as well as of the color information contained in picture elements of the digitalized images 103.

The structure map is constructed of picture elements 307 arranged block-like. Each picture element 307 contains a color information (chrominance values) of the object 152.

The color information is allocated to the triangle 303 in that an

appertaining picture element 307 of the appertaining structure map 306 is respectively allocated to a corner point 302 and 308 of the triangle 303 and 309.

The position of the corner points 308 of the triangle 309 is determined by the specification of coordinates (u_i, v_i) 310 in a two-dimensional coordinate system (u, v) 311 that is allocated to the structure map 306. The coordinates (u_i, v_i) 310 are subsequently normed.

Via a transformation rule, the corresponding point 310 in the appertaining structure map 306 is assigned to each corner point 302 of each triangle 303 of the three-dimensional model 301.

Those picture elements 501 of a structure map that contain a color information relevant for the presentation of the object 152 are transformed into a new triangular structure map 503. The picture elements 506 of the triangular structure map are arranged such that they form a right-angle and equilateral triangle, whereby one side comprises five picture elements. The transformation is implemented such that the picture elements 501 that are corner picture elements 504 of the triangle 505 coincide with picture elements 506 that are corner picture elements 507 of the triangular structure map 503.

In the framework of the transformation, picture elements may potentially have to be generated by an extrapolation or an interpolation of values that contain color information or picture elements may potentially have to be deleted.

The triangular structure map 503 thus comprises only picture elements 506 that are relevant for the presentation of an object.

As shown in Figure 6, all triangular structure maps 601 that contain the color information relevant for the presentation of the object are arranged to [ƒ]form[†] a new superstructure map 602.

To that end, respectively two triangular structure maps 601 are arranged to [ƒ]form[†] a block-shaped structure map 603. Further, all block-shaped structure maps 603 are groups by rows and columns, whereby a digitalized image is

generated.

Due to the uniform and predetermined shape of the triangular structure map, the row-by-row and column-by-column arrangement of the block-shaped structure maps 603 and a predetermined size of the superstructure map 602, a simplified transformation rule or, respectively, a simplified allocation key derives that is referred to as texture binding:

Each triangle 303 of the spatial triangular grid structure 301 of the three-dimensional model of the object 152 has allocated to it a first value n_S that indicates the column number of the triangular structure map 601 belonging to the triangle 303 within the superstructure map 602, a second value n_Z that indicates the row number of the triangular structure map 601 belonging to the triangle 303 within the superstructure map 602, and a third value n_L that indicates the relative position of the triangular structure map 601a or, respectively, 601b with respect to the block-shaped structure map 603.

Upon employment of the value triad (n_S, n_Z, n_L) indicated for each triangle 303 of the spatial grid structure 301 and of the given values in view of the height H (plurality of picture elements, for example 80 picture elements) of the superstructure map having the size HxB and of the given plurality of picture elements Z arranged in a side of the right equilateral triangle with, for example, Z=5 picture elements, an allocation of a triangular structure map 601 of the superstructure map 602 to the appertaining triangle 303 of the volume model 301 of the object is determined according to the following relationships:

$A_x = (Z/B) * (n_S-1)$

$A_y = (Z/H) * (n_Z-1)$

$B_x = (Z/B) * n_S$

$B_y = A_y$

$C_x = B_x$

$C_y = (Z/H) * n_Z$

$D_x = A_x$

$D_y = C$

The corner picture elements (Ax,Ay), (Cx,Cy) and (Dx,Dy) are relevant for the value nL = 0 that describes a triangular structure map 601a arranged at the left within the block-shaped structure map 603.

The corner points (A_x,A_y), $C_x,C_y)$ and (B_x,B_y) are relevant for the value $n_L = 1$ that describes a triangular structure map 601b arranged at the left within the block-shaped structure map 603.

The two values that are identified by the index x and by the index y thereby indicate the coordinates of a point of the superstructure map 602 with respect to a Cartesian coordinate system 610 that is arranged in the upper left corner 611 of the superstructure map 602.

4. Encoding (204)

What is referred to as a Triangle-Adaptive Discrete Cosine Transformation [~~(SA-DCT) [sic~~]] (TA-DCT) is employed for the encoding of the superstructure map 602. This method for encoding a digitalized image is based on the method of a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) as described in [[~~4~~]] the publication by T. Sikora et al., "Shape Adaptive DCT for Generic Coding of Video", IEEE Transactions on Circuits and Systems for Video Technology.

In the framework of a TA-DCT, the transformation coefficients allocated to an image object are defined such that picture elements of an edge image block that do nor belong to the image object are blanked out. A one-dimensional DCT, whose length corresponds to the number of picture elements remaining in the respective column, is then first applied column-by-column to the remaining picture elements. The resulting transformation coefficients are subsequently subjected to a further one-dimensional DCT in horizontal direction with a

corresponding length.

The method of TA-DCT proceeds from a transformation matrix DCT-N having the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

N references a quantity of the image vector to be transformed wherein the transformed picture elements are contained.

DCT-N references a transformation matrix having the size NxN.

p, k reference indices with p, k ∈ [0, N-1].

After the TA-DCT, each column of the image block to be transformed is vertically transformed according to the rule

$$c_j = \sqrt{\frac{2}{N_j}} * [\underline{DCT-N}(p,k)] * x_j \qquad (2)$$

Subsequently, the same rule is applied to the resultant data in horizontal direction.

In the framework of the encoding of a superstructure map 602 upon employment of TA-DCT, the superstructure map 62 is subdivided into the block-shaped structure maps 603. A block-shaped structure map 603 and 901 is thereby divided into a first new block-shaped structure map 902 and a second new block-shaped structure map 903, as shown in Figure 9, in that the picture elements of the second triangular structure map 601b and 904 are deleted for the determination of the first new block-shaped structure map 602. The second new block-shaped structure map 903 is determined in that the picture elements of the first triangular structure map 601a and 905 are deleted.

Further, the second new block-shaped structure map 903 is modified such

by shifting picture elements 906 that the relative position of the picture elements 906 of the second block-shaped structure map 903 with respect to the second new block-shaped structure map 903 coincides with the relative position of the picture elements 907 of the first new block-shaped structure map 902 with respect to the first new block-shaped structure map 902.

The TA-DCT can thus be correspondingly applied to the first new block-shaped structure map 902 and to the second new block-shaped structure map 903.

The TA-DCT can be utilized due to the specific relative position of the picture elements 906 and 907 with respect to the first new block-shaped structure map 902 and the second new block-shaped structure map 903.

5. Transmission (205)

The image information (image information of the superstructure map) encoded upon employment of the TA-DCT is transmitted via a transmission medium 107 to the second computer 108 together with data of the volume model of the object as well as of the allocation $(n_S, n_Z, n_L)_i$ ($i = 1 \ldots N$, with N = number of triangles of the grid structure of the volume model).

6. Decoding (206)

An image decoding is implemented after transmission of the encoded image information.

To that end, the spectral coefficients c_j are supplied to an inverse TA-DCT.

Given inverse TA-DCT in the framework if image encoding in the intra-image encoding mode, picture elements x_j are formed from the spectral coefficients c_j according to the following rule (4):

$$x_j = \sqrt{\frac{2}{N}} * [\underline{DCT-N}(p,k)]^{-1} * c_j \qquad (4)$$

whereby the transformation matrix DCT-N comprises the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

whereby

-- N references a size of the image vector to be transformed wherein the picture elements to be transformed are contained;

-- [DCT-N (p, k)] references a transformation matrix having the size NxN;

-- p, k reference indices with p, k ∈ [0, N-1];

-- $( )^{-1}$ references an inversion of a matrix.

The decoded image or, respectively, the superstructure map 602 is determined upon employment of the determined picture elements x_j.

7. Presentation of the Object (207)

The model of the object 152 is presented on the picture screen 108 upon employment of the superstructure map, the data of the volume model of the object 152 as well as the allocation$(n_S, n_Z, n_L)_i$ (i = 1 ... N, with N = number of triangles of the grid structure of the volume model), as described in [[~~6~~]] the Internet publication PANORAMA technical Support, available on 12 October 1998 at: http://www.tnt.uni-hannover.de/project/eu/panorama/TS.html.

Although other modifications and changes may be suggested by those skilled in the art, it is the intention of the inventors to embody within the patent warranted hereon all changes and modifications as reasonably and properly come within the scope of their contribution to the art.

[~~The following documents were cited in this document:~~

~~[1] D. Le Gall, "The Video Compression Standard for Multimedia Applications", Communications of ACM, Vol. 34, No. 4, pp. 47-58, April 1991.~~

~~[2] G. Wallace, "The JPEG Still Picture Compression Standard, Communications of ACM, Vol. 34, No. 4, pp. 31-44, April 1991.~~

~~[3] De Lameillieure, J., et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK, Volume 48, No. 3/1994, 1994.~~

~~[4] T. Sikora, B. Makai, "Shape Adaptive DCT for Generic Coding of Video"< IEEE Transactions on Circuits and Systems for Video Technology, Vol. 5, pp. 59-62, Feb. 1995.~~

~~[5] J. D. Foley, et al., "Computer graphics: principles and practise", 2nd Ed., Adison-Wesley, ISBN 0 -20112110-7, pp. 741-744.~~

~~[6] PANORAMA technical Support, available on 12 October 1998 at: http://www.tnt.uni-hannover.de/project/eu/panorama/TS.html~~

~~[7] W. Niem, et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, 6-8 September 1998, Santorini, Greece, 1998.~~]

[~~Patent Claims~~] I claim:

1. (Amended) A method [~~Method~~] for processing a digitalized image with picture elements that contain an encoding information, comprising the steps of:

[~~a)   whereby~~]

dividing the image is at least partially [~~divided~~] into image blocks;

[~~b)   whereby~~]

subdividing an appertaining image block [~~is~~] respectively [~~subdivided~~] into at least two appertaining image sub-blocks;

[~~characterized in that the~~]

implementing processing of the image [~~is implemented~~] such that a first value and [,] a second value and a third value are respectively allocated to at least one image sub-block, [~~whereby~~] the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

2. (Amended) A method [Method] according to claim 1, wherein said step of subdividing provides that [~~whereby~~] the appertaining image block is subdivided into a plurality of appertaining image sub-blocks.

3. (Amended) A method [Method] according to claim 1 [~~or 2~~], wherein said step of implementing provides that [whereby] the first value and [,] the second value and the third value are respectively allocated to each appertaining image sub-block.

4. (Amended) A method [Method] according to claim [one of the claims] 1, wherein [through 3, whereby] the image blocks are arranged in columns and

rows [and/or column numbers are assigned to the columns and row numbers are assigned to the rows].

5. (Amended) A method [Method] according to claim 29 [4], wherein a [whereby the] first value of the appertaining image sub-block is the row number of the appertaining image block and a [the] second value of the appertaining image sub-block is the column number of the appertaining image block.

6. (Amended) A method [Method] according to claim [one of the claims] 1 [through 5], wherein [whereby] the appertaining image sub-blocks exhibit a different shape than the appertaining image block.

7. (Amended) A method [Method] according to claim [one of the claims] 1, wherein [through 6, whereby] the image sub-blocks are of [comprise] a triangular shape.

8. (Amended) A method [Method] according to claim 7, wherein [whereby] the triangular shape includes [comprises] a right angle.

9. (Amended) A method [Method] according to claim [one of the claims] 1 [through 8], further comprising the step of: [whereby]

modifying the appertaining image sub-blocks [are modified] such that the respective position of an appertaining image sub-block with respect to the appertaining image block is respectively identical.

10. (Amended) A method [Method] according to claim [one of the claims] 1, further comprising the step of:

utilizing the steps for [through 9 utilized in the framework of an] encoding of the image.

11. (Amended) A method [Method] according to claim 10, further comprising the steps of: [whereby]

encoding the image sub-blocks [are encoded] upon employment of the encoding information [and/or upon employment of the first value, the second value and the third value] with a shape-adaptive transformation encoding.

12. (Amended) A method [Method] according to claim 11, wherein [whereby] a shape-adaptive Discrete Cosine Transformation [~~(DCT)~~] is utilized for the encoding.

13. (Amended) A method [Method] according to claim 12, wherein [whereby] a Shape-Adaptive Discrete Cosine Transformation [(SA-DCT)] is utilized for the encoding.

14. (Amended) A method [Method] according to claim 13, wherein [whereby] a Triangle-Adaptive Discrete Cosine Transformation [(TA-DCT)] is utilized for the encoding.

15. (Amended) A method [Method] according to claim [one of the claims] 1, wherein the steps are [through 9] utilized in the framework of a decoding of the image.

16. (Amended) A method [Method] according to claim 15, wherein [whereby] an inverse shape-adaptive Discrete Cosine Transformation [(DCT)] is utilized for the decoding.

17. (Amended) A method [Method] according to claim 16, wherein [whereby] an inverse Shape-Adaptive Discrete Cosine Transformation [(SA-

DCT)] is utilized for the decoding.

18. (Amended) A method [Method] according to claim 17, wherein [whereby] an inverse Triangle-Adaptive Discrete Cosine Transformation [(TA-DCT)] is utilized for the decoding.

19. (Amended) A method [Method] according to claim [one of the claims] 1, wherein [through 18, whereby] the image at least partly includes [comprises] triangular structure maps.

20. (Amended) An arrangement [Arrangement] for processing a digitalized image with picture elements that contain an encoding information, comprising: [whereby]

a processor [is provided] that is configured such that the following method steps can be implemented:

[a)] the image is at least partially divided into image blocks;

[b)] an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

[characterized in that] the processing of the image is implemented such that a first value and [,] a second value and a third value are respectively allocated to at least one image sub-block, [whereby] the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

21. (Amended) An arrangement [Arrangement] according to claim 20, wherein [whereby] the appertaining image block is [can be] subdivided into a plurality of appertaining image sub-blocks.

22. (Amended) An arrangement [Arrangement] according to claim 20 [or 21], wherein [whereby] the respective first value and the respective second value and the respective third value are [can be] allocated to each appertaining image sub-block.

23. (Amended) An arrangement [Arrangement] according to claim [one of the claims] 20, wherein the processor is [through 22 that can be] utilized in [the framework of] an encoding of the image.

24. (Amended) An arrangement [Arrangement] according to claim 23, wherein [whereby] a shape-adaptive Discrete Cosine Transformation is [(DCT) can be] utilized for the encoding.

25. (Amended) An arrangement [Arrangement] according to claim 24, wherein [whereby] an inverse Triangle-Adaptive Discrete Cosine Transformation is [(TA-DCT) can be] utilized for the encoding.

26. (Amended) An arrangement [Arrangement] according to claim [one of the claims] 20, wherein the processor is [through 25 that can be] utilized in the framework of a decoding of the image.

27. (Amended) An arrangement [Arrangement] according to claim 26, wherein [whereby] an inverse shape-adaptive Discrete Cosine Transformation is [(DCT) can be] utilized for the decoding.

28. (Amended) An arrangement [Arrangement] according to claim 27, wherein [whereby] an inverse Triangle-Adaptive Discrete Cosine Transformation is [(TA-DCT) can be] utilized for the decoding.

29. A method according to claim 1, further comprising the step of: assigning column numbers to the columns and row numbers to the rows.

30. A method according to claim 10, further comprising the steps of: encoding the image sub-blocks upon employment of the first value and the second value and the third value with a shape-adaptive transformation encoding.

Abstract of the Disclosure

[METHOD AND ARRANGEMENT FOR PROCESSING A DIGITALIZED IMAGE]

Methods and arrangements are recited for processing a digitalized image with picture elements that contain an encoding information. To that end, the image is divided into image blocks and a respective image block is divided into two image sub-blocks. The processing of the image is implemented such that a respective first value and a respective second value and a respective third value is allocated to an image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block. Further, the employment of the method and of the arrangement in the framework of an encoding and decoding is recited.

[Figure 2]

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METHOD AND ARRANGEMENT FOR PROCESSING A DIGITALIZED IMAGE

The invention is directed to an arrangement and to a method for processing a digitalized image as utilized and implemented in the framework of an encoding and decoding of a digitalized image.

Such a method and such an arrangement are utilized in the framework of an encoding and decoding of a digitalized image corresponding to one of the image encoding standards H.261 [1], H.263 [2] of MPEG2 [3] that are based on the principle of a block-based image encoding. According to [3], the method of a block-based discrete cosine transformation (DCT) is employed for block-based image encoding.

Another approach for processing a digitalized image corresponding to the image encoding standard MPEG4 is what is referred to as the principle of object-based image encoding, as known from [3].

In object-based image encoding, a segmentation of an image master into image blocks ensues corresponding to objects occurring in a scene, and a separate encoding of these objects ensues.

Components of a standard arrangement for an image encoding, as also known from [7], and of an image decoding can be derived from Figure 7.

Figure 7 shows a camera 701 with which images are registered. The camera 701 can, for example, be an arbitrary analog camera 701 that registers images of a scene and either digitalizes the images in the camera 701 and transmits the digitalized images to a first computer 702 that is coupled to the camera 701 or transmits the images to the first computer 702 in analog form as well. In the first computer 702, the analog images are converted into digitalized images and the digitalized images are processed.

The camera 701 can also be a digital camera 701 with which directly digitalized images are registered and supplied to the first computer 702 for further processing.

The first computer 702 can also be designed as an autonomous arrangement with which the method steps described below are implemented, for example as an autonomous computer card that is installed in a further computer.

What is to be generally understood by the first computer 702 is a unit that can implement an image signal processing according to the method described below, for example a mobile terminal device (mobile telephone with a picture screen).

The first computer 702 comprises a processor unit 704 with which the method steps of the image encoding and image decoding described below are implemented. The processor unit 704, for example, is coupled via a bus 705 to a memory 706 in which an image information is stored.

In general, the methods described below can be realized both in software as well as in hardware or partly in software and partly in hardware.

After the image encoding has ensued in the first computer 701 and after the transmission of the encoded image information via a transmission medium 707 to a second computer 708, the image decoding is implemented in the second computer 708.

The second computer 708 can have the same structure as the first computer 701. The second computer 708 thus also comprises a processor 709 that is coupled to a memory 710 by a bus 711.

Figure 8 shows a possible arrangement in the form of a schematic diagram of the image encoding or, respectively, image decoding. The illustrated arrangement can be employed within the framework of a block-based image encoding and -- also shall be explained in greater detail later -- can be employed in part within the framework of an object-based image encoding.

In the block-based image encoding, a digitalized image 801 is divided into what are usually quadratic image blocks 820 having a size of 8x8 picture elements 802 or 16x16 picture elements 802 and is supplied to the arrangement 803 for image encoding.

Coding information, for example brightness information (luminance values) and/or color information (chrominance values), is usually allocated to a picture element 802.

In block-based image encoding, a distinction is made between different image encoding modes.

In what is referred to as intra-image encoding, the digitalized image 801 is respectively encoded with the coding information allocated to the picture elements 802 of the digitalized image and is transmitted.

In what is referred to as an inter-image encoding, only a difference image information of two chronologically successive, digitalized images 801 is respectively encoded and transmitted.

The difference information is very small when movements of image objects are slight in the chronologically successive, digitalized images 801. When the movements are great, then a great deal of difference information arises that is difficult to encode. For this reason and as known from [3], an "image-to-image" movement (motion estimate) is measured and compensated before the determination of the difference information (motion compensation).

There are different methods for the motion estimation and the motion compensation as known from [3]. What is referred to as a "block matching method" is usually utilized for the block-based image encoding. It is based thereon that an image block to be encoded is compared to reference image blocks of the same size in a reference image. The sum of the absolute differences of an encoding information that is respectively allocated to a picture element is usually employed as criterion for a coincidence quality between the block to be encoded and a respective reference image block. In this way, a motion information for the image block is determined, for example a motion vector, this being transmitted with the difference information.

Two switch units 804 are provided for switching between the intra-image encoding and the inter-image encoding. A subtraction unit 805 wherein the difference of the image information of two chronologically successive, digitalized images 801 is formed is provided for the implementation of the inter-image encoding. The image encoding is controlled via an image encoding control unit 806. The image blocks 820 to be encoded or, respectively, difference image blocks are respectively supplied to a transformation encoding unit 807. The transformation encoding unit 807 applies a

transformation encoding, for example a discrete cosine transformation (DCT), to the encoding information allocated to the picture elements 802.

In general, however, any desired transformation encoding, for example a discrete sine transformation or a discrete Fourier transformation, can be applied for the image encoding.

Spectral coefficients (transformation coefficients) are formed by the transformation encoding. The spectral coefficients are quantized in a quantization unit 808 and are supplied to an image encoding multiplexer 821, for example to a channel encoding and/or to an entropy encoding. The quantized spectral coefficients are inversely quantized in an inverse quantization unit 809 and are subjected to an inverse transformation encoding in an inverse transformation encoding unit 810.

In the case of inter-image encoding, further, image information of the respective, chronologically preceding image are added in an adder unit 811. The images reconstructed in this way are stored in a memory 812. For simpler presentation, a unit relating to the motion compensation 813 is symbolically presented in the memory 812.

Further, a loop filter 814 is provided that is connected to the memory 812 as well as to the subtraction unit 805.

In addition to a transmitted image information 822, a mode index that respectively indicates whether an intra-image encoding or inter-image encoding was undertaken is also supplied to the image encoding multiplexer 821.

Further, quantization indices 816 for the spectral coefficients are supplied to the image encoding multiplexer 821.

A motion vector is respectively allocated to an image block 820 and/or to a macro block 823 that, for example, comprises four image blocks 820 and is supplied to the image encoding multiplexer 821.

Further, an information particular for the activation or, respectively, deactivation of the loop filter is provided. After transmission of the image information via a transmission medium 818, the decoding of the transmitted information can ensue in a second computer 819. To this end, an image decoding unit

825 is provided in the second computer 819, this unit 825, for example, comprising the structure of a reconstruction loop of the arrangement shown in Figure 8.

[4] discloses a shape-adapted transformation encoding is specifically applied in the framework of an object-based image encoding to edge image block or image blocks that contain only partially relevant encoding information. The edge image blocks encoded upon employment of a shape-adapted transformation encoding are characterized in that only the picture elements that are allocated to an object or, respectively, that comprise encoding information relevant to the object are encoded.

The method described in [4] is what is referred to as a shape-adapted Discrete Cosine Transformation (Shape-Adaptive DCT, SA-DCT).

Within the framework of an SA-DCT, the transformation coefficients allocated to an image object are defined such that picture elements of an edge image block that do not belong to the image object are blanked out. A one-dimensional DCT is then initially applied to the remaining picture elements column-by-column, the length thereof corresponding to the number of remaining picture elements in the respective column. The resulting transformation coefficients are horizontally aligned are a subsequently subject in [sic] a further one-dimensional DCT in horizontal direction with corresponding length.

The rule of SA-DCT known from [4] proceeds from a transformation matrix DCT-N having the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

N references a quantity of the image vector to be transformed wherein the transformed picture elements are contained.

DCT-N references a transformation matrix having the size NxN.

p, k reference indices with p, k ∈ [0, N-1].

After the SA-DCT, each column of the image block to be transformed is vertically transformed according to the rule

$$c_j = \sqrt{\frac{2}{N_j}} * [\underline{DCT - N}(p,k)] * x_j \qquad (2)$$

Subsequently, the same rule is applied to the resultant data in horizontal direction.

Various methods for the presentation of an object on a picture screen are employed in computer graphics. One method for the presentation of a subject is what is referred to as texture mapping.

[5] discloses such a texture mapping.

In the framework of texture mapping, a digital image that contains a brightness information (luminance values) and/or a color information (chrominance values) of the object to be presented is mapped onto a surface of a three-dimensional model of an object to be presented.

The three-dimensional model 301 of the object to be presented, said model 301 being shown in Figure 3, is composed of a spatial, triangular grid structure 301, whereby the corner points 302 of the triangles 303 are present as points 304 of a Cartesian coordinate system 305.

As shown in Figure 3, what is referred to as a block-shaped structure map 306 is allocated to each triangle 303, as shown in Figure 3, said map 306 being constructed of picture elements 307 that are arranged rectangularly or, respectively, block-like. A brightness information (luminance values) and/or a color information (chrominance values) is usually allocated to each picture element 307.

The brightness or color information is allocated to the triangle 303 such that an appertaining picture element 307 of the appertaining structure map 306 is respectively allocated to a corner point 302 and 308 of the triangle 303 and 309.

The position of a corner point 308 of the triangle 309 is defined by the indication of coordinates (u_i, v_i) 310 in a two-dimensional coordinate system (u, v) 311 that is assigned to the structure map 306. The coordinates (u_i, v_i) 310 are usually normed.

Via a transformation rule (allocation or, respectively, allocation key), the corresponding point 310 in the appertaining structure map 306 is allocated to each corner point 302 of each triangle 303 of the three-dimensional model 301.

As shown in Figure 4, further, all structure maps 401 are combined into a digitalized image 402, what is referred to as a superstructure map 402, wherein the individual structure maps 401 are arranged row-by-row and column-by-column. As warranted, the structure maps 401, which contain encoding information relevant for the presentation of the object, must be supplemented with structure maps 404 that contain no encoding information that is relevant for the presentation of the subject.

In particular, however, the above-described method exhibits a disadvantage. The structure maps and the superstructure maps as well comprise picture elements that contain no brightness or color information relevant for the representation of the object.

When the superstructure map is encoded in the framework of an image transmission, then the data rate occurring in the transmission is unnecessarily increased by the non-relevant picture elements.

For improving the above method, a structure map is processed in the following way (see Figure 5):

Those picture elements 501 of a structure map 502 that contain picture elements [...] an encoding information relevant for the presentation of the object are transformed into a new triangular structure map 503 with picture elements 506 that are arranged in a predetermined shape -- usually a right triangle -- and in a predetermined size. The transformation is implemented such that the picture elements 501, which are corner picture elements 504 of the triangle 505, coincide with picture elements 506 that are corner picture elements 507 of the triangular structure map.

In the scope of the transformation, picture elements may potentially have to be generated by an extrapolation or an interpolation of values that contain a brightness or color information or picture elements may potentially have to be deleted.

The triangular structure map 503 thus only comprises picture elements 506 that are relevant for the presentation of an object.

As shown in Figure 6, all triangular structure maps 601 that contain brightness or color information relevant for the presentation of the object are arranged to form a new superstructure map 602.

To that end, respectively two triangular structure maps 601a and 601b are arranged to form a block-shaped structure map 603.

Further, all block-shaped structure maps 603 are grouped by rows and columns, a digitalized image being thus generated.

[5] also discloses that such a superstructure map as generated in the framework of a texture mapping is encoded and decoded in an image transmission.

The encoding and/or decoding of a superstructure map thereby usually ensues upon employment of a block-oriented transformation in the intra-image encoding mode, as was set forth above.

As implemented in the framework of a processing of a digital image, this procedure is not very efficient in view of a low data rate to be desired for a transmission or in view of a higher image quality.

The invention is thus based on the problem of specifying a method for processing a digitalized image and an arrangement for processing a digitalized image with which a more efficient processing of a digitalized image becomes possible.

The problem is solved by the method comprising the features according to the independent claims as well as by the arrangements comprising the features according to the independent claims.

In the method for processing a digitalized image with picture elements that contain an encoding information, the image is at least partly divided into image blocks. Respectively one image block is subdivided into at least two appertaining image sub-blocks. The processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one appertaining image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

In the arrangement for processing a digitalized image having picture elements that contain an encoding information, a processor is provided that is configured such that the following method steps can be implemented:
The image is at least partially divided into image blocks. Respectively one image block is subdivided into at least two appertaining image sub-blocks. The processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one of the appertaining image sub-blocks, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

Preferred developments of the invention derive from the dependent claims.

In one development, which effects a simplification of the method, the image blocks are arranged in rows and columns and/or column numbers are assigned to the columns and row numbers are assigned to the rows. The allocation expediently ensues such that the first value of the appertaining image sub-block is the row number of the appertaining image block and the second value of the appertaining image sub-block is the column number of the appertaining image block.

In another development, an image sub-block exhibits a different shape than the appertaining image block. Preferably, the shape of the image sub-block is a triangle that has a right angle. Such a shape of an image sub-block reduces the calculating outlay for a shape-adaptive transformation encoding.

The image sub-blocks are preferably combined to form the image. The image thus comprises only picture elements that contain encoding information relevant for an object.

It is also advantageous to modify the image sub-blocks such that the relative position of an image sub-block is respectively identical with respect to the appertaining image block. A shape-adaptive transformation encoding can thus be applied in the framework of an encoding and/or an inverse transformation encoding can be applied in the framework of a decoding, being applied to all image sub-blocks of the appertaining image block.

One development is utilized in the framework of an encoding and/or decoding of the image.

It is thereby advantageous to encode the image sub-blocks with a shape-adaptive transformation encoding upon employment of the encoding information and/or upon employment of the first value, second value and third value and/or to decode the image sub-blocks with an inverse shape-adaptive transformation encoding. An efficient encoding and/or decoding of the image is thereby achieved.

A simplification derives when, in one development, a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) for encoding and/or an inverse SA-DCT for decoding is/are employed.

A further simplification derives when a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) for encoding and/or an inverse TA-DCT for decoding is/are employed.

An exemplary embodiment of the invention is shown in the Figures and is explained in greater detail below.

Shown are:

Figure 1 arrangement for image encoding and image decoding with a registration of an object with a camera and a presentation of the object on a picture screen;

Figure 2 schematic illustration of the procedure for image encoding and image decoding with a registration of an object with a camera and a presentation of the object on a picture screen;

Figure 3 triangular grid structure of a three-dimensional model with an appertaining structure map;

Figure 4 illustration of a superstructure map;

Figure 5 illustration of a transformation of a structure map onto a triangular structure map;

Figure 6 illustration of a superstructure map composed of triangular structure maps;

Figure 7 arrangement for image encoding or, respectively, image decoding with a camera, two computers and a transmission medium;

Figure 8 sketch of an arrangement for block-based image encoding or, respectively, image decoding;

Figure 9 illustration of the resolution of the block-shaped structure map.

Figure 1 shows an arrangement for an image encoding and an image decoding with a registration of an object with a camera and a presentation of the object on a picture screen.

Figure 1 shows a camera 101 with which images of an object 152 are registered. The camera 101 is an analog color camera that registers images of the object 152 and transmits the images to a first computer 102 in analog form. in the first computer 102, the analog images are converted into digitalized images, whereby picture elements of the digitalized images contain a color information of the object 152, and the digitalized images are processed.

The object 152 is arranged centered on an object carrier 153. The relative position of the object carrier 153 with respect to the camera 101 is permanently prescribed. By rotating the object carrier 153 around its center, the object 152 can be moved such that the angle of view from which the camera 101 registers the object 152 changes continuously given an unmodified distance of the object 152 from the camera 101.

The first computer 102 is configured as an autonomous arrangement in the form of an autonomous computer card that is installed in the first computer 102, the method steps described below being implemented with said computer card.

The first computer 102 comprises a processor 104 with which the method steps of image encoding described below are implemented. The processor unit 104 is coupled via a bus 105 to a memory 106 in which an image information is stored.

The method for image encoding described below is realized in software. It is stored in the memory 106 and is implemented by the processor 104.

After the image encoding has ensued in the first computer 101 and after a transmission of the encoded image information via a transmission medium 107 to a second computer 108, the image decoding is implemented in the second computer 108. Subsequently, a model of the object 152 is presented on a picture screen 155

linked to the second computer 108 upon employment of the decoded image information of the object 152.

The second computer 108 has the same structure as the first computer 101. The second computer 108 also comprises a processor 109, said processor being coupled to a memory 110 with a bus 111.

The method described below for the image decoding is realized in software. It is stored in the memory 110 and is implemented by the processor 109.

Figure 2 schematically shows the procedure for a processing of a digitalized image in the framework of an encoding and of a decoding with a registration of an object with a camera and a presentation of the object on a picture screen.

This procedure for the encoding and the decoding is realized by the arrangement shown in Figure 1 and described above.

1st Step Registration of the Object (201)

Upon employment of the camera 101 as described in [7], images of the object 152 are registered, said object 152 being rotated in its position relative to the camera 101 in predetermined rotational angles with the object carrier 153. The images are transmitted to the first computer 102 in analog form.

Before the implementation of the registration of the object 152, the camera 101 is calibrated, as described in [7], whereby a spatial geometry of the arrangement as well as the exposure parameters of the camera 101, for example the focal length of the camera 101, are defined.

The geometry data as well as the camera parameters are transmitted to the first computer 102.

2. Digitalizing the Images (202)

The analog images are converted into digitalized images in the first computer 102 and the digitalized images are processed.

3. Image Processing (203)

The processing of the digitalized images 103 ensues according to the method of automatic three-dimensional modeling upon employment of a plurality of images of the object, as described in [7].

Two method steps are implemented in the framework of the method of automatic three-dimensional modeling upon employment of a plurality of images of an object:

In the first step of the method, a volume model 301 of the object 152 is determined with a method for determining a contour of an object in a digitalized image, as cited in [7], upon employment of the camera parameters and of the digitalized images 103.

The volume model 301 of the object 152, as shown in Figure 3, is composed of a spatial, triangular grid structure 301, whereby the corner points 302 of the triangles 303 are present as points 304 of a Cartesian coordinate system 305.

In the second step of the method, what is referred to as a structure map 306 is determined for each triangle 303 upon employment of the digitalized images 103 as well as of the color information contained in picture elements of the digitalized images 103.

The structure map is constructed of picture elements 307 arranged block-like. Each picture element 307 contains a color information (chrominance values) of the object 152.

The color information is allocated the triangle 303 in that an appertaining picture element 307 of the appertaining structure map 306 is respectively allocated to a corner point 302 and 308 of the triangle 303 and 309.

The position of the corner points 308 of the triangle 309 is determined by the specification of coordinates (u_i, v_i) 310 in a two-dimensional coordinate system (u, v) 311 that is allocated to the structure map 306. The coordinates (u_i, v_i) 310 are subsequently normed.

Via a transformation rule, the corresponding point 310 in the appertaining structure map 306 is assigned to each corner point 302 of each triangle 303 of the three-dimensional model 301.

Those picture elements 501 of a structure map that contain a color information relevant for the presentation of the object 152 are transformed into a new triangular structure map 503. The picture elements 506 of the triangular structure map are arranged such that they form a right-angle and equilateral triangle, whereby one side comprises five picture elements. The transformation is implemented such that the picture elements 501 that are corner picture elements 504 of the triangle 505 coincide with picture elements 506 that are corner picture elements 507 of the triangular structure map 503.

In the framework of the transformation, picture elements may potentially have to be generated by an extrapolation or an interpolation of values that contain color information or picture elements may potentially have to be deleted.

The triangular structure map 503 thus comprises only picture elements 506 that are relevant for the presentation of an object.

As shown in Figure 6, all triangular structure maps 601 that contain the color information relevant for the presentation of the object are arranged to [form] a new superstructure map 602.

To that end, respectively two triangular structure maps 601 are arranged to [form] a block-shaped structure map 603. Further, all block-shaped structure maps 603 are groups by rows and columns, whereby a digitalized image is generated.

Due to the uniform and predetermined shape of the triangular structure map, the row-by-row and column-by-column arrangement of the block-shaped structure maps 603 and a predetermined size of the superstructure map 602, a simplified transformation rule or, respectively, a simplified allocation key derives that is referred to as texture binding:

Each triangle 303 of the spatial triangular grid structure 301 of the three-dimensional model of the object 152 has allocated to it a first value n_S that indicates the column number of the triangular structure map 601 belonging to the triangle 303 within the superstructure map 602, a second value n_Z that indicates the row number of the triangular structure map 601 belonging to the triangle 303 within the superstructure map 602, and a third value n_L that indicates the relative position of the

triangular structure map 601a or, respectively, 601b with respect to the block-shaped structure map 603.

Upon employment of the value triad (n_S, n_Z, n_L) indicated for each triangle 303 of the spatial grid structure 301 and of the given values in view of the height H (plurality of picture elements, for example 80 picture elements) of the superstructure map having the size HxB and of the given plurality of picture elements Z arranged in a side of the right equilateral triangle with, for example, Z=5 picture elements, an allocation of a triangular structure map 601 of the superstructure map 602 to the appertaining triangle 303 of the volume model 301 of the object is determined according to the following relationships:

$A_x = (Z/B) * (n_S-1)$

$A_y = (Z/H) * (n_Z-1)$

$B_x = (Z/B) * n_S$

$B_y = A_y$

$C_x = B_x$

$C_y = (Z/H) * n_Z$

$D_x = A_x$

$D_y = C$

The corner picture elements (Ax,Ay), (Cx,Cy) and (Dx,Dy) are relevant for the value nL = 0 that describes a triangular structure map 601a arranged at the left within the block-shaped structure map 603.

The corner points (A_x,A_y), C_x,C_y) and (B_x,B_y) are relevant for the value n_L = 1 that describes a triangular structure map 601b arranged at the left within the block-shaped structure map 603.

The two values that are identified by the index x and by the index y thereby indicate the coordinates of a point of the superstructure map 602 with respect to a Cartesian coordinate system 610 that is arranged in the upper left corner 611 of the superstructure map 602.

4. Encoding (204)

What is referred to as a Triangle-Adaptive Discrete Cosine Transformation (SA-DCT) [sic] is employed for the encoding of the superstructure map 602. This method for encoding a digitalized image is based on the method of a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) as described in [4].

In the framework of a TA-DCT, the transformation coefficients allocated to an image object are defined such that picture elements of an edge image block that do nor belong to the image object are blanked out. A one-dimensional DCT, whose length corresponds to the number of picture elements remaining in the respective column, is then first applied column-by-column to the remaining picture elements. The resulting transformation coefficients are subsequently subjected to a further one-dimensional DCT in horizontal direction with a corresponding length.

The method of TA-DCT proceeds from a transformation matrix DCT-N having the following structure:

$$\underline{DCT-N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2}\right) * \frac{\pi}{N}\right] \qquad (1)$$

with p, k = 0 → N-1.

N references a quantity of the image vector to be transformed wherein the transformed picture elements are contained.

DCT-N references a transformation matrix having the size NxN.

p, k reference indices with p, k ∈ [0, N-1].

After the TA-DCT, each column of the image block to be transformed is vertically transformed according to the rule

$$c_j = \sqrt{\frac{2}{N_j}} * [\underline{DCT-N}(p,k)] * x_j \qquad (2)$$

Subsequently, the same rule is applied to the resultant data in horizontal direction.

In the framework of the encoding of a superstructure map 602 upon employment of TA-DCT, the superstructure map 62 is subdivided into the block-shaped structure maps 603. A block-shaped structure map 603 and 901 is thereby

divided into a first new block-shaped structure map 902 and a second new block-shaped structure map 903, as shown in Figure 9, in that the picture elements of the second triangular structure map 601b and 904 are deleted for the determination of the first new block-shaped structure map 602. The second new block-shaped structure map 903 is determined in that the picture elements of the first triangular structure map 601a and 905 are deleted.

Further, the second new block-shaped structure map 903 is modified such by shifting picture elements 906 that the relative position of the picture elements 906 of the second block-shaped structure map 903 with respect to the second new block-shaped structure map 903 coincides with the relative position of the picture elements 907 of the first new block-shaped structure map 902 with respect to the first new block-shaped structure map 902.

The TA-DCT can thus be correspondingly applied to the first new block-shaped structure map 902 and to the second new block-shaped structure map 903.

The TA-DCT can be utilized due to the specific relative position of the picture elements 906 and 907 with respect to the first new block-shaped structure map 902 and the second new block-shaped structure map 903.

5. Transmission (205)

The image information (image information of the superstructure map) encoded upon employment of the TA-DCT is transmitted via a transmission medium 107 to the second computer 108 together with data of the volume model of the object as well as of the allocation $(n_S, n_Z, n_L)_i$ ($i = 1 \ldots N$, with N = number of triangles of the grid structure of the volume model).

6. Decoding (206)

An image decoding is implemented after transmission of the encoded image information.

To that end, the spectral coefficients c_j are supplied to an inverse TA-DCT.

Given inverse TA-DCT in the framework if image encoding in the intra-image encoding mode, picture elements x_j are formed from the spectral coefficients c_j according to the following rule (4):

$$x_j = \sqrt{\frac{2}{N}} * [\underline{DCT - N}(p,k)]^{-1} * c_j \qquad (4)$$

whereby the transformation matrix DCT-N comprises the following structure:

$$\underline{DCT - N}(p,k) = \gamma * \cos\left[p * \left(k + \frac{1}{2} \right) * \frac{\pi}{N} \right] \qquad (1)$$

with p, k = 0 → N-1.

whereby

-- N references a size of the image vector to be transformed wherein the picture elements to be transformed are contained;

-- [DCT-N (p, k)] references a transformation matrix having the size NxN;

-- p, k reference indices with p, k ∈ [0, N-1];

-- $( )^{-1}$ references an inversion of a matrix.

The decoded image or, respectively, the superstructure map 602 is determined upon employment of the determined picture elements x_j.

7. Presentation of the Object (207)

The model of the object 152 is presented on the picture screen 108 upon employment of the superstructure map, the data of the volume model of the object 152 as well as the allocation$(n_S, n_Z, n_L)_i$ (i = 1 ... N, with N = number of triangles of the grid structure of the volume model), as described in [6].

The following documents were cited in this document:

[1] D. Le Gall, "The Video Compression Standard for Multimedia Applications", Communications of ACM, Vol. 34, No. 4, pp. 47-58, April 1991.

[2] G. Wallace, "The JPEG Still Picture Compression Standard, Communications of ACM, Vol. 34, No. 4, pp. 31-44, April 1991.

[3] De Lameillieure, J., et al., "MPEG-2-Bildcodierung für das digitale Fernsehen" in FERNSEH- UND KINO-TECHNIK, Volume 48, No. 3/1994, 1994.

[4] T. Sikora, B. Makai, "Shape Adaptive DCT for Generic Coding of Video"< IEEE Transactions on Circuits and Systems for Video Technology, Vol. 5, pp. 59-62, Feb. 1995.

[5] J. D. Foley, et al., "Computer graphics: principles and practise", 2^{nd} Ed., Adison-Wesley, ISBN 0 -20112110-7, pp. 741-744.

[6] PANORAMA technical Support, available on 12 October 1998 at: http://www.tnt.uni-hannover.de/project/eu/panorama/TS.html

[7] W. Niem, et al., "Mapping texture from multiple Camera Views onto 3D Object Models for Computer Animation", Proc. of International Workshop on Stereoscopic and Three Dimensional Imaging, 6-8 September 1998, Santorini, Greece, 1998.

Patent Claims

1. Method for processing a digitalized image with picture elements that contain an encoding information,

a) whereby the image is at least partially divided into image blocks;

b) whereby an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

characterized in that the processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

2. Method according to claim 1, whereby the appertaining image block is subdivided into a plurality of appertaining image sub-blocks.

3. Method according to claim 1 or 2, whereby the first value, the second value and the third value are respectively allocated to each appertaining image sub-block.

4. Method according to one of the claims 1 through 3, whereby the image blocks are arranged in columns and rows and/or column numbers are assigned to the columns and row numbers are assigned to the rows.

5. Method according to claim 4, whereby the first value of the appertaining image sub-block is the row number of the appertaining image block and the second value of the appertaining image sub-block is the column number of the appertaining image block.

6. Method according to one of the claims 1 through 5, whereby the appertaining image sub-blocks exhibit a different shape than the appertaining image block.

7. Method according to one of the claims 1 through 6, whereby the image sub-blocks comprise a triangular shape.

8. Method according to claim 7, whereby the triangular shape comprises a right angle.

9. Method according to one of the claims 1 through 8, whereby the appertaining image sub-blocks are modified such that the respective position of an appertaining image sub-block with respect to the appertaining image block is respectively identical.

10. Method according to one of the claims 1 through 9 utilized in the framework of an encoding of the image.

11. Method according to claim 10, whereby the image sub-blocks are encoded upon employment of the encoding information and/or upon employment of the first value, the second value and the third value with a shape-adaptive transformation encoding.

12. Method according to claim 11, whereby a shape-adaptive Discrete Cosine Transformation (DCT) is utilized for the encoding.

13. Method according to claim 12, whereby a Shape-Adaptive Discrete Cosine Transformation (SA-DCT) is utilized for the encoding.

14. Method according to claim 13, whereby a Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is utilized for the encoding.

15. Method according to one of the claims 1 through 9 utilized in the framework of a decoding of the image.

16. Method according to claim 15, whereby an inverse shape-adaptive Discrete Cosine Transformation (DCT) is utilized for the decoding.

17. Method according to claim 16, whereby an inverse Shape-Adaptive Discrete Cosine Transformation (SA-DCT) is utilized for the decoding.

18. Method according to claim 17, whereby an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) is utilized for the decoding.

19. Method according to one of the claims 1 through 18, whereby the image at least partly comprises triangular structure maps.

20. Arrangement for processing a digitalized image with picture elements that contain an encoding information, whereby a processor is provided that is configured such that the following method steps can be implemented:

a) the image is at least partially divided into image blocks;

b) an appertaining image block is respectively subdivided into at least two appertaining image sub-blocks;

characterized in that the processing of the image is implemented such that a first value, a second value and a third value are respectively allocated to at least one image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block.

21. Arrangement according to claim 20, whereby the appertaining image block can be subdivided into a plurality of appertaining image sub-blocks.

22. Arrangement according to claim 20 or 21, whereby the respective first value and the respective second value and the respective third value can be allocated to each appertaining image sub-block.

23. Arrangement according to one of the claims 20 through 22 that can be utilized in the framework of an encoding of the image.

24. Arrangement according to claim 23, whereby a shape-adaptive Discrete Cosine Transformation (DCT) can be utilized for the encoding.

25. Arrangement according to claim 24, whereby an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) can be utilized for the encoding.

26. Arrangement according to one of the claims 20 through 25 that can be utilized in the framework of a decoding of the image.

27. Arrangement according to claim 26, whereby an inverse shape-adaptive Discrete Cosine Transformation (DCT) can be utilized for the decoding.

28. Arrangement according to claim 27, whereby an inverse Triangle-Adaptive Discrete Cosine Transformation (TA-DCT) can be utilized for the decoding.

Abstract

METHOD AND ARRANGEMENT FOR PROCESSING A DIGITALIZED IMAGE

Methods and arrangements are recited for processing a digitalized image with picture elements that contain an encoding information. To that end, the image is divided into image blocks and a respective image block is divided into two image sub-blocks. The processing of the image is implemented such that a respective first value and a respective second value and a respective third value is allocated to an image sub-block, whereby the first value and the second value describe the relative position of the appertaining image block with respect to the image and the third value describes the relative position of the appertaining image sub-block with respect to the appertaining image block. Further, the employment of the method and of the arrangement in the framework of an encoding and decoding is recited.

Figure 2

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EPO - Munich
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20. Jan. 2000

FIG 1

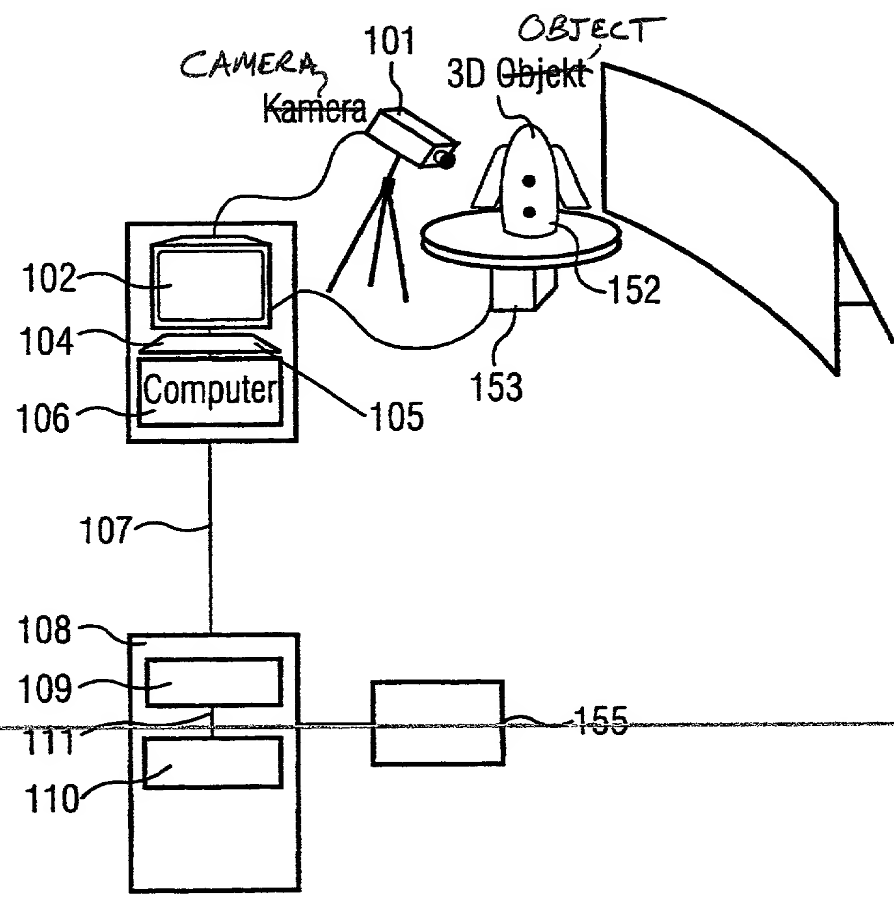

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FIG 2

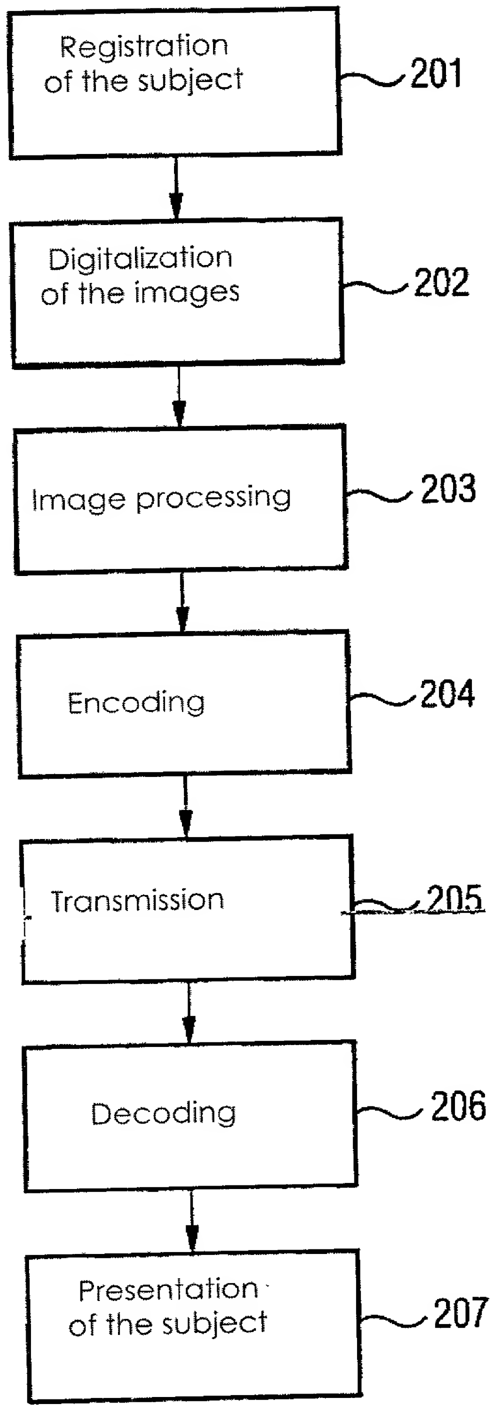

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FIG 3

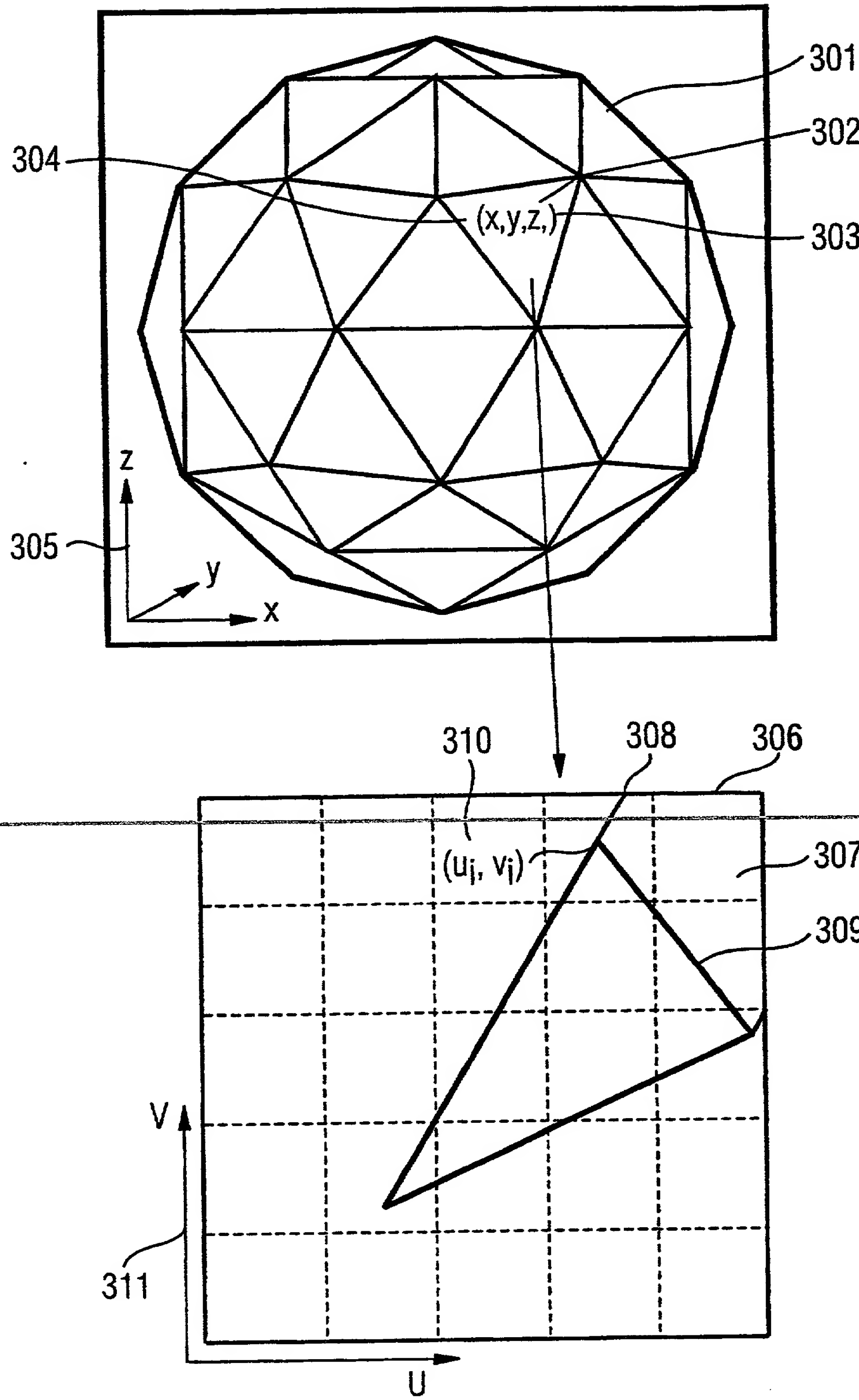

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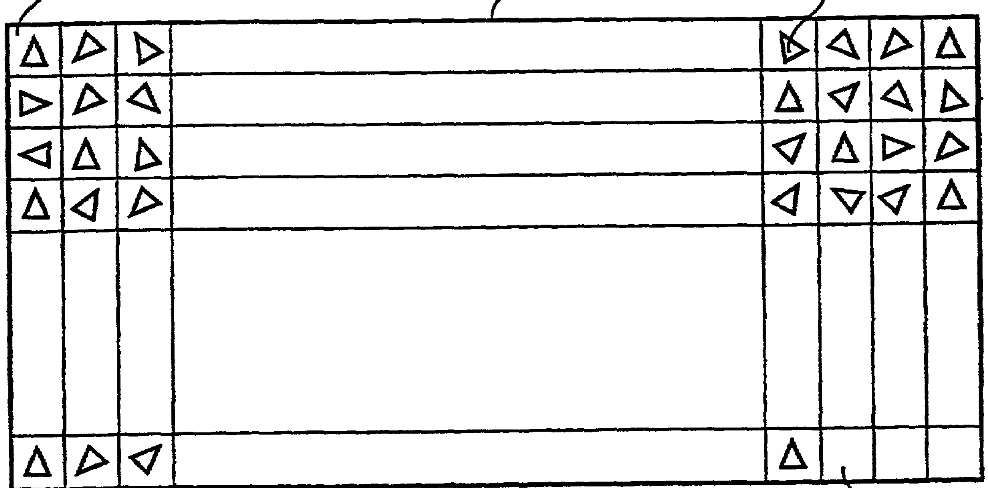
FIG 4



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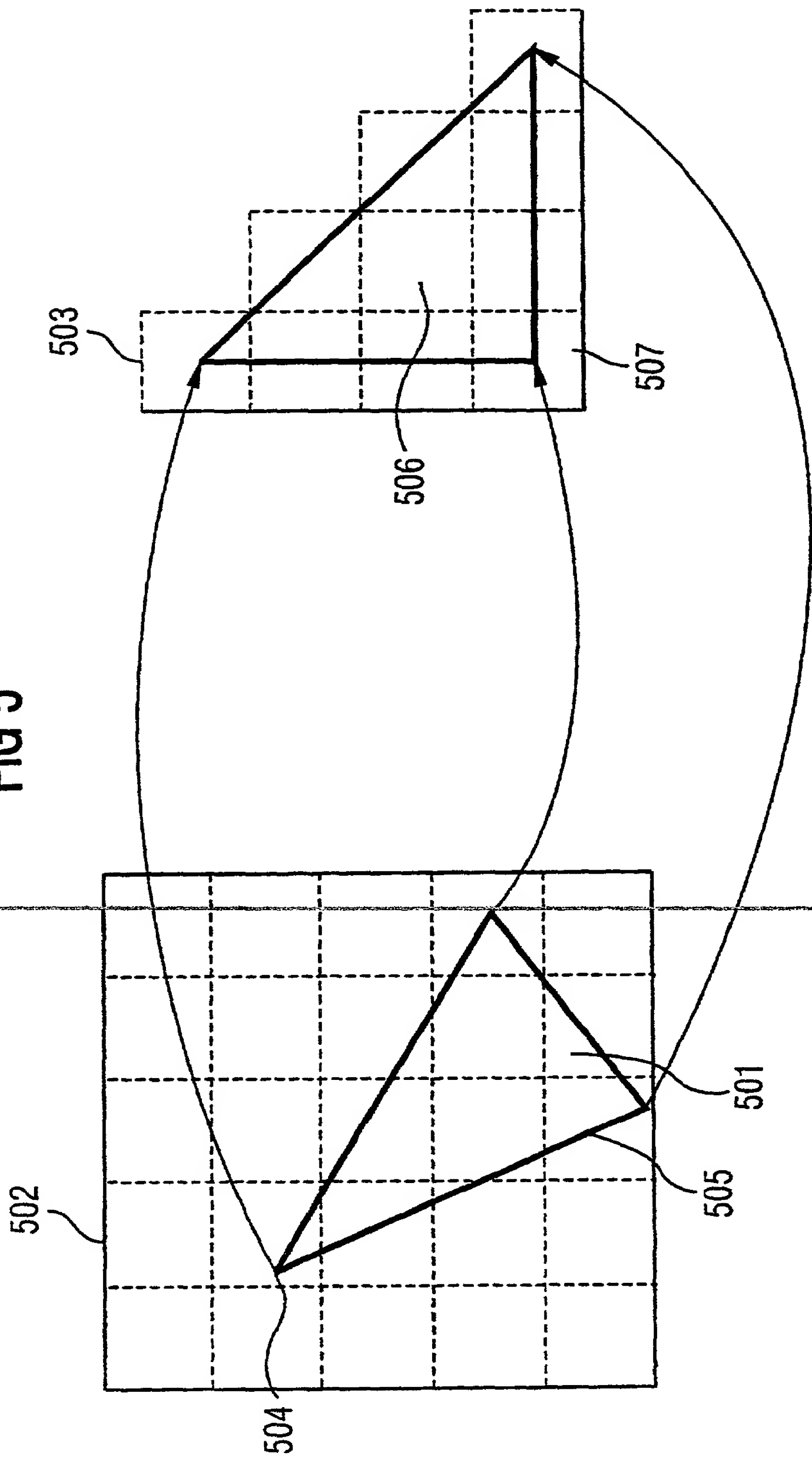

FIG 5

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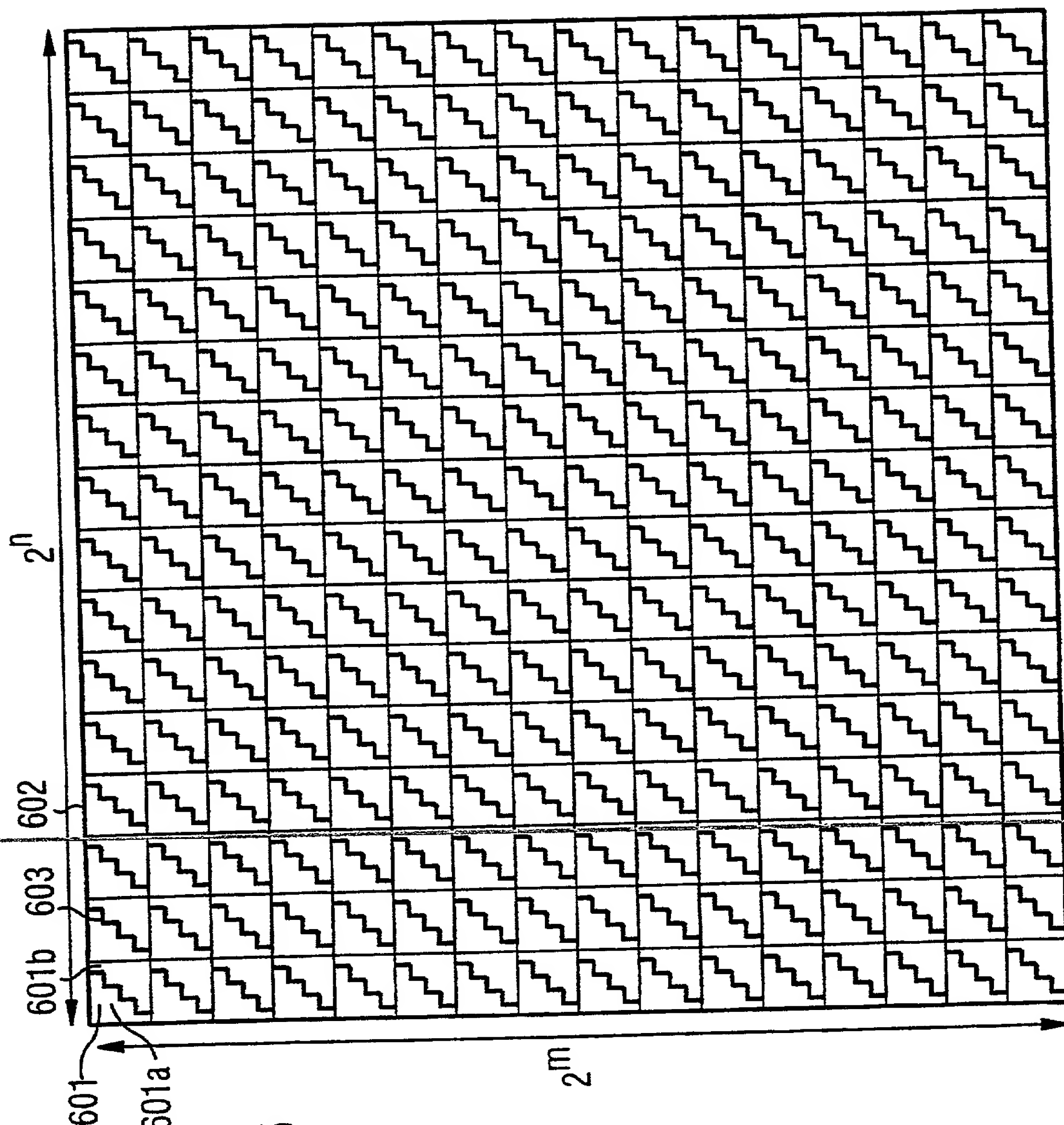

FIG 6

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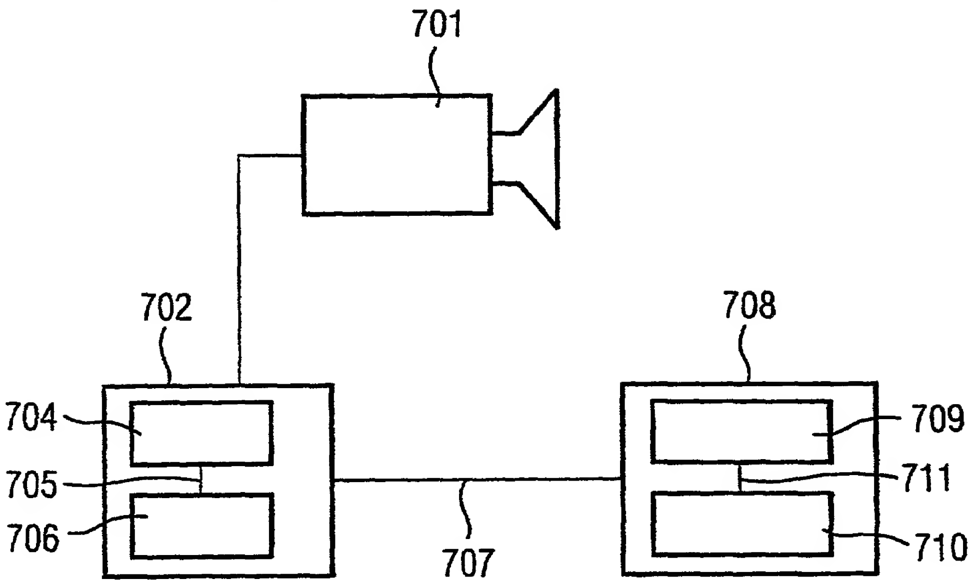
FIG 7



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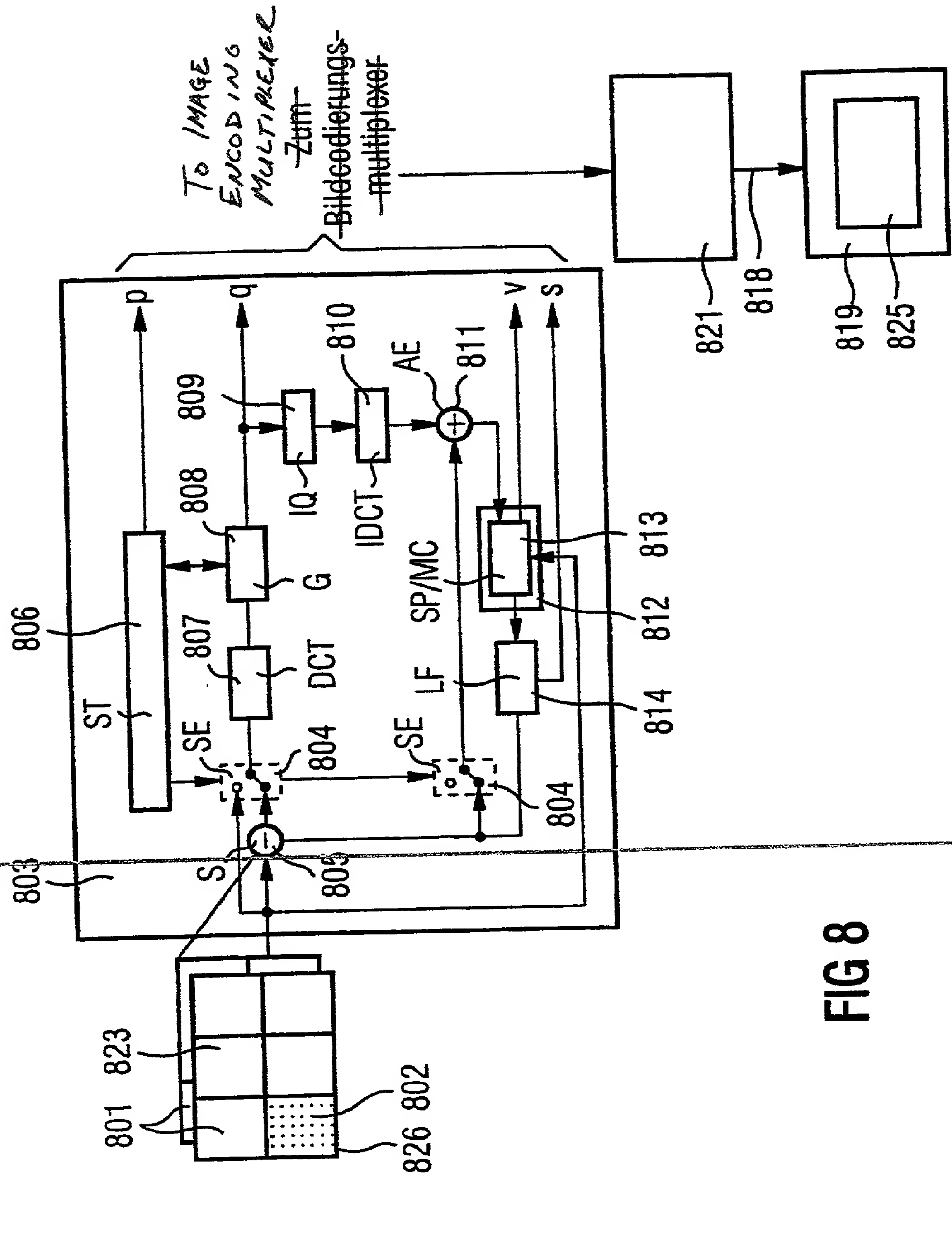

FIG 8

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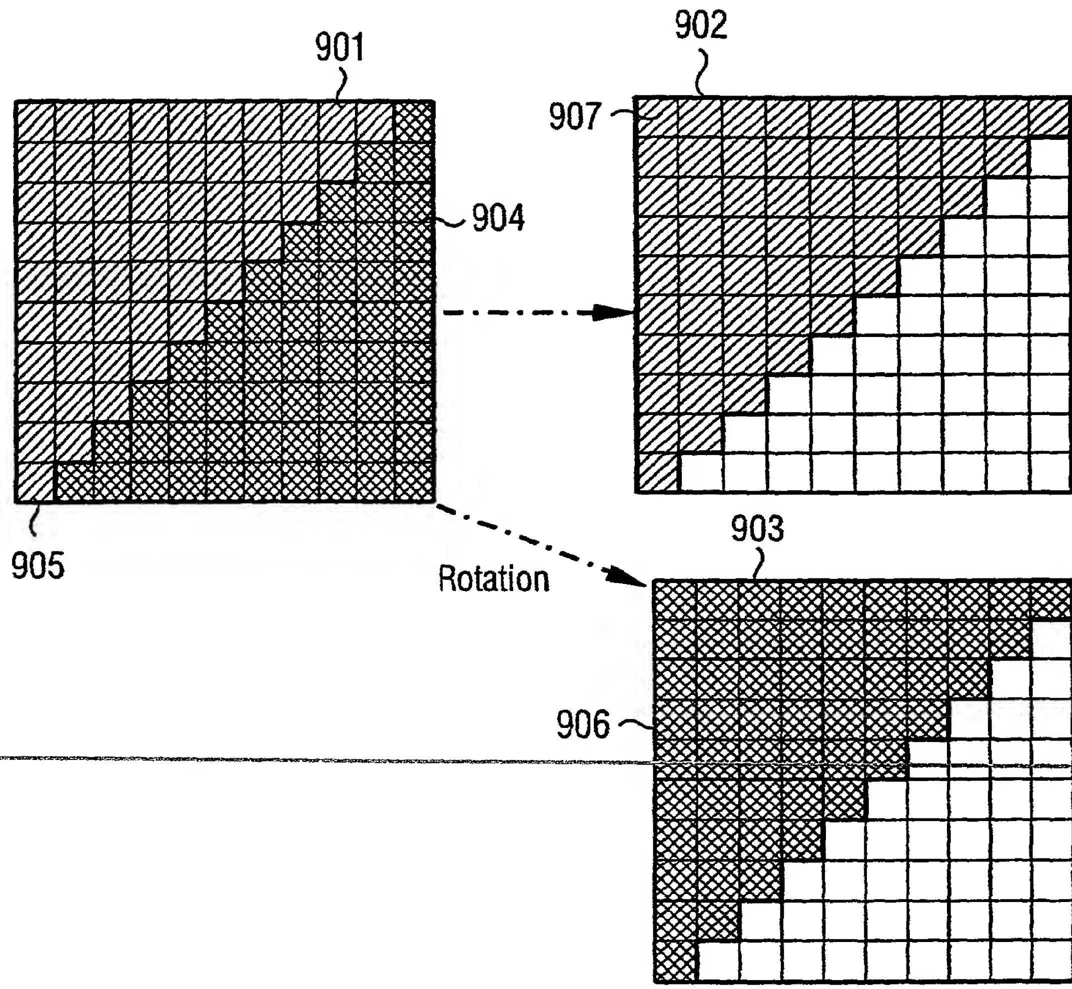
FIG 9



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German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: *(Name und Registrationsnummer anführen)*

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

And I hereby appoint

Messrs. John D. Simpson (Registration No. 19,842) Lewis T. Steadman (17,074), William C. Stueber (16,453), P. Phillips Connor ~~(19,259)~~, Dennis A. Gross (24,410), Marvin Moody (16,549), Steven H. Noll (28,982), Brett A. Valiquet (27,841), Thomas I. Ross (29,275), Kevin W. Guynn (29,927), Edward A. Lehmann (22,312), James D. Hobart (24,149), Robert M. Barrett (30,142), James Van Santen (16,584), J. Arthur Gross (13,615), ~~Richard J. Schwarz~~ (13,472) and Melvin A. Robinson (31,870), David R. Metzger (32,919), John R. Garrett (27,888) all members of the firm of Hill, Steadman & Simpson, A Professional Corporation.

Telefongespräche bitte richten an: *(Name und Telefonnummer)*

Direct Telephone Calls to: *(name and telephone number)*

312/876-0200
Ext. ______________

Postanschrift:

Send Correspondence to:

HILL, STEADMAN & SIMPSON
A Professional Corporation
85th Floor Sears Tower, Chicago, Illinois 60606

Voller Name des einzigen oder ursprünglichen Erfinders: RIEGEL, Thomas	Full name of sole or first inventor:
Unterschrift des Erfinders: Riegel Thomas — Datum: 10/11/1999	Inventor's signature — Date
Wohnsitz: D-81739 München, Germany DEX	Residence
Staatsangehörigkeit: Bundesrepublik Deutschland	Citizenship
Postanschrift: Therese-Giehse-Allee 85	Post Office Address
D-81739 München Bundesrepublik Deutschland	
Voller Name des zweiten Miterfinders (falls zutreffend):	Full name of second joint inventor, if any:
Unterschrift des Erfinders — Datum	Second Inventor's signature — Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

19

10

Declaration and Power of Attorney For Patent Application
Erklärung Für Patentanmeldungen Mit Vollmacht
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Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Verfahren und Anordnung zur Bearbeitung eines digitalisierten Bildes

deren Beschreibung

(zutreffendjhaes ankreuzen)

☒ hier beigefügt ist.

☐ am ____________ als PCT internationale Anmeldung
PCT Anmeldungsnummer ____________
Eingereicht wurde und am ____________
Abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

____

the specification of which

(check one)

☐ is attached hereto.

☐ was filed on ____________ as PCT international application
PCT Application No. ____________
and was amended on ____________
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign appplications
Priorität beansprucht

Priority Claimed

(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
198 48 987.0	Germany	23. Oktober 1998	☒	☐
			☐	☐
			☐	☐

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.) (Anmeldeseriennummer)	(Filing Date) (Anmeldedatum)	(Status) (patentiert, anhängig, aufgegeben)	(Status) (patented, pending, abandoned)

(Application Serial No.) (Anmeldeseriennummer) — (Filing Date) (Anmeldedatum) — (Status) (patentiert, anhängig, aufgeben) — (Status) (patented, pending, abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden koennen, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.